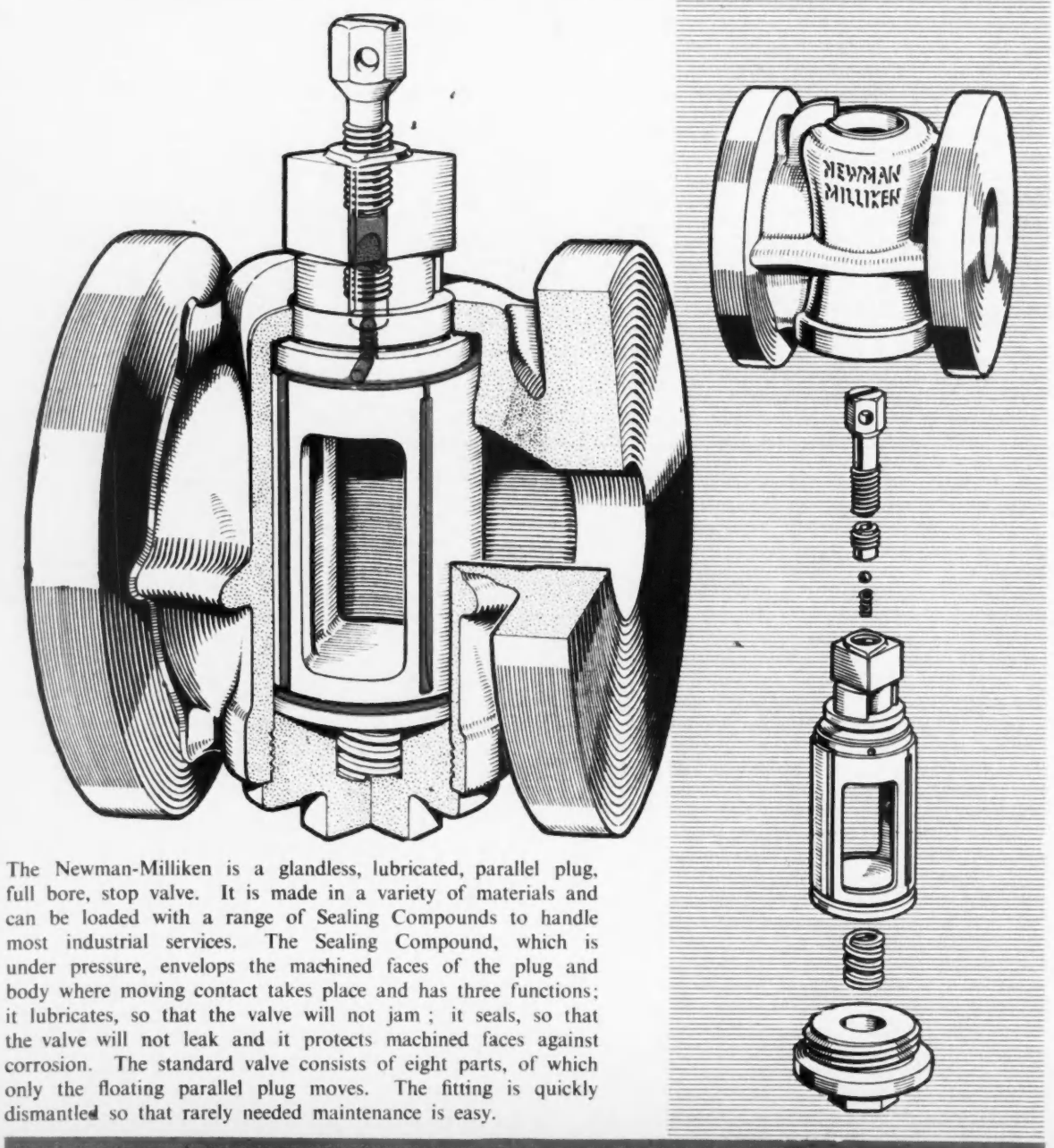
The Engineer

MARCH 7, 1958 — 28 ESSEX ST., STRAND, LONDON, W.C.2 — TWO SHILLINGS

Newman-Milliken

Glandless lubricated plug valves



The Newman-Milliken is a glandless, lubricated, parallel plug, full bore, stop valve. It is made in a variety of materials and can be loaded with a range of Sealing Compounds to handle most industrial services. The Sealing Compound, which is under pressure, envelops the machined faces of the plug and body where moving contact takes place and has three functions; it lubricates, so that the valve will not jam ; it seals, so that the valve will not leak and it protects machined faces against corrosion. The standard valve consists of eight parts, of which only the floating parallel plug moves. The fitting is quickly dismantled so that rarely needed maintenance is easy.

PRINCIPAL STOCKISTS AND SERVICE AGENTS

BELL'S ASBESTOS AND ENGINEERING LIMITED

(Specialists in Applied Asbestos and Plant Maintenance)

BESTOBELL WORKS, SLOUGH, BUCKS

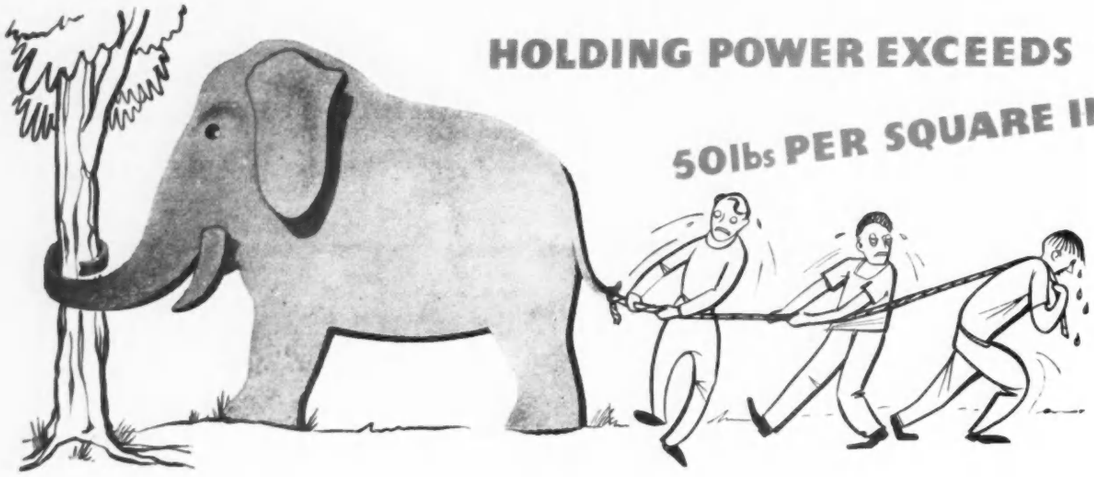
Telephone: Slough 23181

The word 'Bestobell' and the crest shown are the registered trade marks of Bell's Asbestos and Engineering Limited

UNITED KINGDOM BRANCHES

BELFAST — BIRMINGHAM — CARDIFF
GLASGOW — HULL — LEEDS
LIVERPOOL — LONDON — MANCHESTER
NEWCASTLE ON TYNE — NOTTINGHAM
SLOUGH — TAUNTON
EIRE (DUBLIN AGENCY)

WRITE FOR A COPY OF BROCHURE NO. 14 WHICH GIVES FULL DETAILS OF NEWMAN-MILLIKEN VALVES



HOLDING POWER EXCEEDS

50lbs PER SQUARE INCH

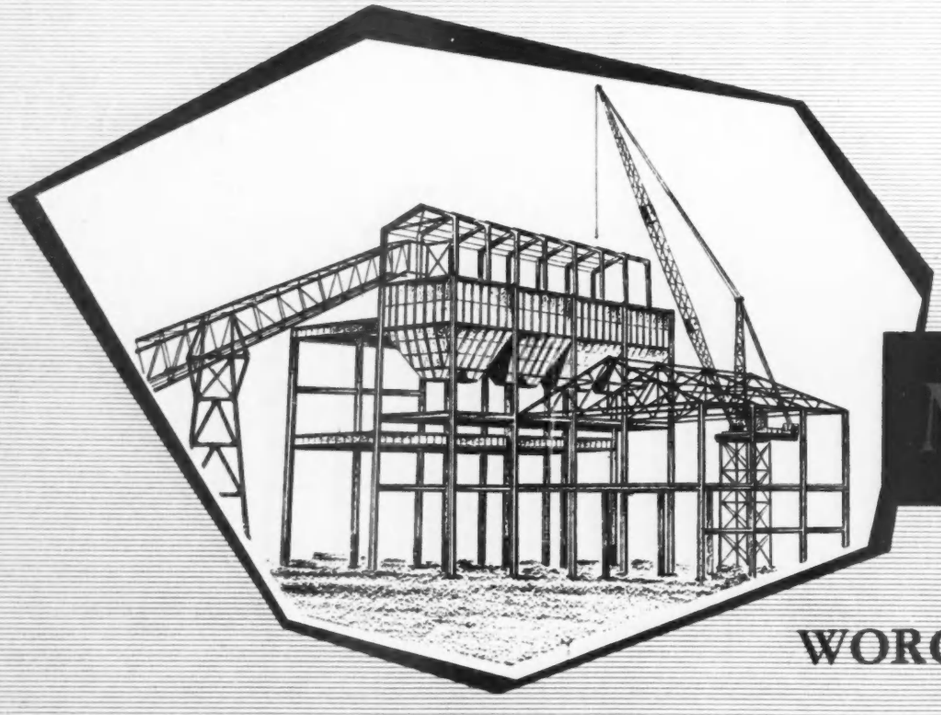
CROID 65
MACHINE FIXING GLUE
COOPERS
FELT

More than 1,000 factories have done away with bolts, grouting, damaged floors; made layout changes a matter of hours; practically eliminated machine vibration. How? By adopting the Croid-Cooper method of machine installation where machines are stuck down on a felt base with a holding power of 50 lbs. to the square inch. Send for details to-day.

COOPER & CO. (B'HAM), LTD.
BRYNMAWR BRECONSHIRE
Telephone: Brynmawr 312. Telegrams: Felting Brynmawr

METAL CONSTRUCTIONS LIMITED

Structural Engineers



M·C·L

WORCESTER

THE ENGINEER

Established 1856

No. 5328 **MARCH 7, 1958** VOL. 205

EDITORIAL CONTENTS

Leading Articles

Oil Engine Evolution 345
Estimates for the Armed Forces 346
Trans-Antarctica 346
Machine Tools 347
Ross Spur Motorway 347

Articles

100 Years Ago 347
W. Johnson Indentation and Forging and the Action of Nasmyth's Anvil 348
R. Hicks Laterally Loaded Plates 350
Mr. Thomas Hornbuckle—An Appreciation 355
Trans-Antarctic Transport 356
Sir George Edwards Transport Speeds 358
Gas Plant Projects in Britain 359
London Helicopter Terminal 359
Semi-Conductor Rectifier Factory 362
Laboratory Chassis Dynamometer 366
Air Sprung Trailer 368
Embakasi Airport, Nairobi 368
275MW Generating Units for C.E.G.B. 369
Institution of Electrical Engineers 369
Industrial Films 369
Chamber of Shipping Report 369
Marchwood Power Station 369
Prefabricated Steel Buildings 370
Lightweight Tractor 370
Scottish Water Power 370

Continental Section

Continuous Casting Plant for Steel 372
Series 1010 Electric Locomotive 373

American Section

Progress of the Tennessee Valley Authority. No. I 374

LETTERS Railways into Roadways. Early Lawn Mowers 360

BOOK REVIEWS 360

NEWS AND NOTES Industrial and Labour Notes 371
Personal and Business 378
British Patent Specifications 379
Forthcoming Engagements 380
Advanced Engineering Courses 380

INDEX TO ADVERTISERS : 131 **CLASSIFIED ADVERTISEMENTS : PAGE 120**

NOTICE TO READERS No undertaking can be given to return illustrations or manuscripts. Correspondents are requested to keep copies. No notice is taken of anonymous communications.

SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 7s. 6d. each. Postage 1s. 9d. extra.

Published every Friday by
MORGAN BROTHERS (PUBLISHERS) LTD., at 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone: CENtral 6565

on VISCO
MODERN
DUST COLLECTION

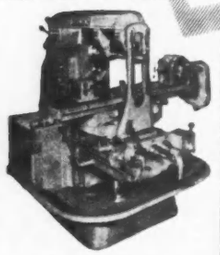
If you have a dust recovery or powder handling problem of any kind, you will find this brochure both useful and interesting. In it we discuss dust collection in general and give numerous examples of the application of dust recovery equipment to various industries.
The information in the brochure is based on many years' experience in dealing with practically every kind of material in powder or fibrous form. It also contains many illustrations showing different types of equipment ranging from large centralized plant with "Visco-Beth" Automatic Dust Collectors to small units for use with individual grinding or polishing machines.

Ask for "Modern Dust Collection", free on request.

THE VISCO ENGINEERING COMPANY LTD.
STAFFORD ROAD · CROYDON
Phone Croydon 4181

HALIFAX TOOL CO. LTD. use RICHMOND MACHINES

THE 600 GROUP OF COMPANIES

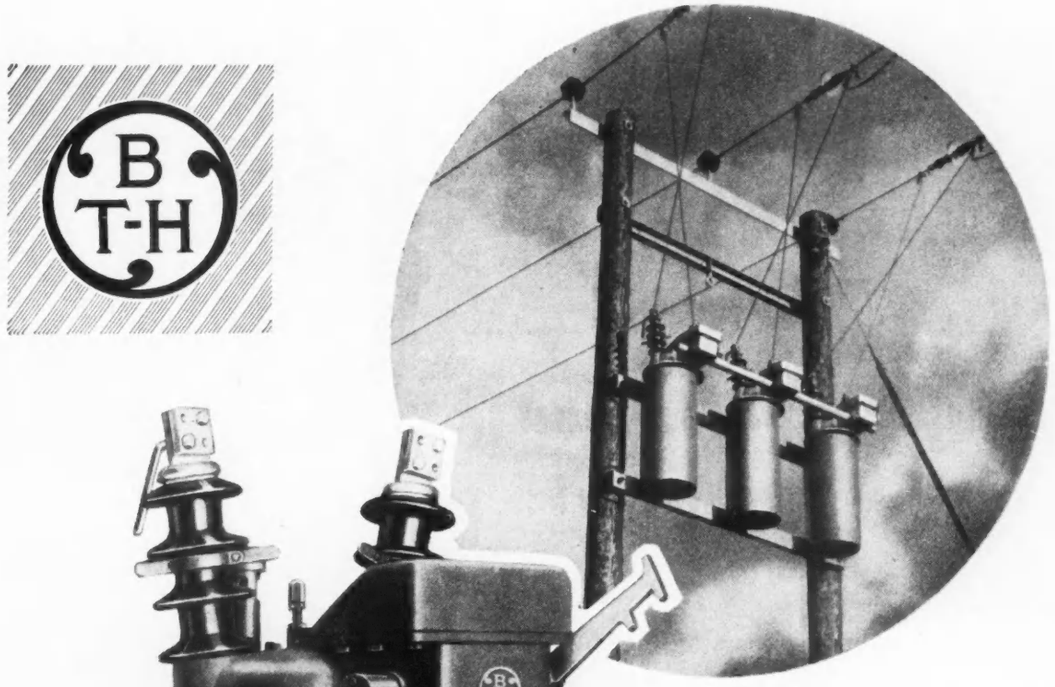


NO. 4 UNIVERSAL MILLING MACHINE

The photograph shows a Richmond No. 4 Universal Milling Machine fitted with Universal Milling head in use at the Halifax Tool Co. Ltd. This machine is all-geared for high speed work to critical limits.

SEND FOR LEAFLETS

giving specifications and full technical information of
RICHMOND MILLING & DRILLING MACHINES
MIDGLEY & SUTCLIFFE LTD.
Hillidge Works, LEEDS 10.
Tel: LEEDS 76032.3



BTH 11-kV AUTOMATIC CIRCUIT-RECLOSERS

improve continuity of supply on rural lines.

Operating in conjunction with slow-blowing fuses, the BTH automatic circuit-recloser prevents transient faults from causing lengthy interruptions of supply.

BRITISH THOMSON-HOUSTON

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · WILLESDEN · ENGLAND

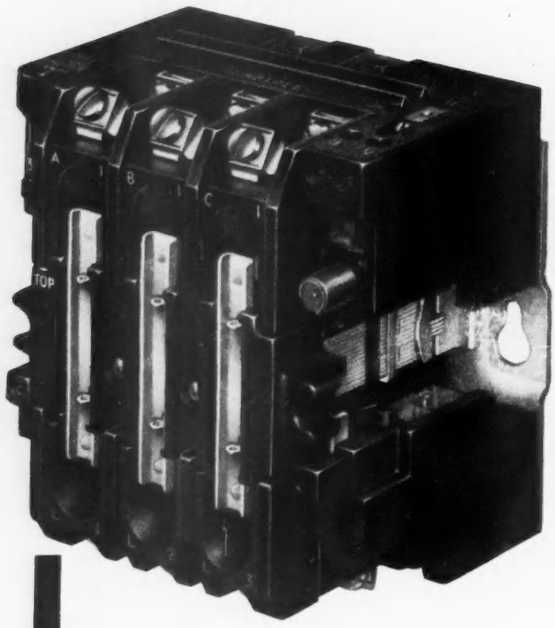
an A.E.I. Company

A 5175

A.S.E.E. EXHIBITION—VISIT OUR STAND NO. J12.

B

positive proof of long life



. . . actual motor-load life tests!

The life of starter contacts should not be forecast from their loss of weight after a few thousand operations because the rate of wear can, of course, vary considerably. The most reliable method is to use the starter for *stopping and starting a motor repeatedly until the contacts are burnt away.*

Such tests are now proceeding on Crabtree Type B-15 starters taken at random from warehouse stocks. To date, the starters have given the following operations (start and stop) without change of contacts or other components:

(a) Controlling a 5 h.p. motor: 2,750,000 operations;

(b) Controlling a 1 h.p. motor: 2,750,000 operations.

these tests are continuing

facts about Crabtree Type B-15 starters

Crabtree

Type B-15 starters

1. *The first and still the leading starter of "unit" construction.*
2. *Wide range of adjustment for full-load current variations.*
3. *Built-in, on-load, interlocked isolating switch unit can be added. Fuses to B.88: 1952, Cat. 440 AC4 are optional.*
4. *Enclosures for general purpose and heavy industrial use.*
5. *Frontal access to all terminals and components.*
6. *Built-in trip signalling.*
7. *Single-screw fixing for additional auxiliary contacts.*
8. *Rating. Motor-load: 15 amp. (10 h.p. 415 volts. 3 phase). Non-inductive load: 25 amp. (6 KVA) per pole.*

C.769

J. A. CRABTREE & CO. LTD., LINCOLN WORKS, WALSALL

GENERAL FABRICATION

WELDING

PROFILE CUTTING

consult

ROBERTSON & FERGUSON LTD.

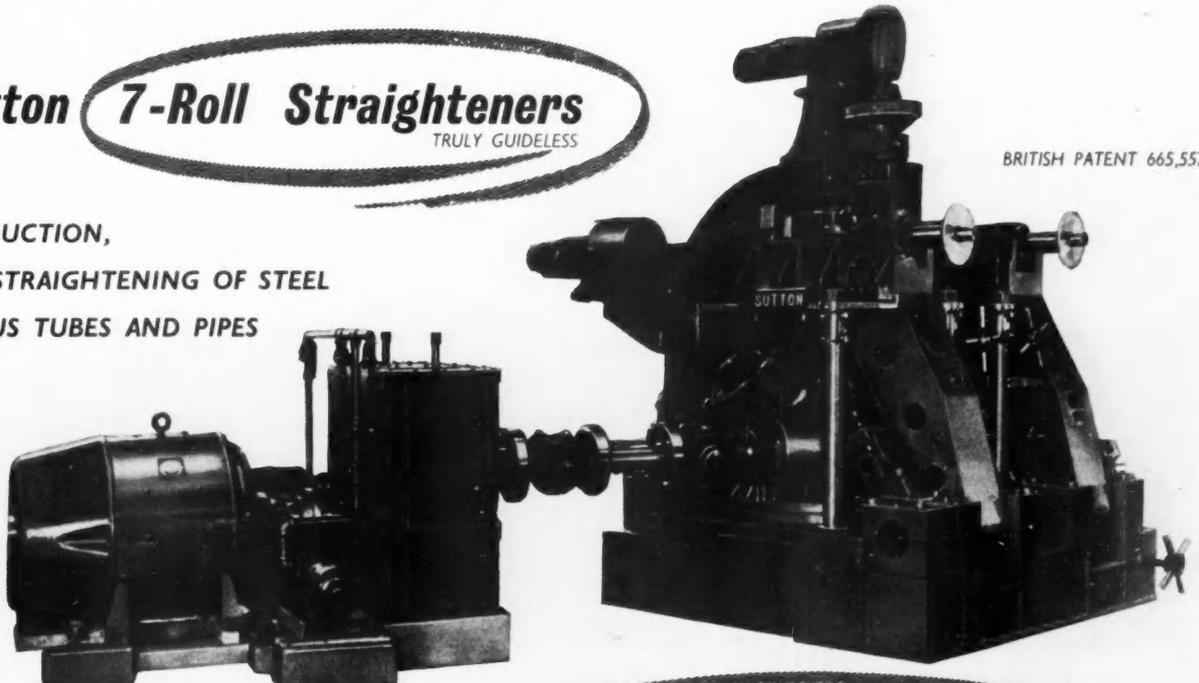
29, MURIESTON CRESCENT, EDINBURGH, 11 Telephone :— 8501 - 2 - 3

A STATOR FRAME
FOR A SYNCHRONOUS MOTOR
WEIGHT APPROX. 6 TONS.

. . . . Sutton 7-Roll Straighteners
TRULY GUIDELESS

BRITISH PATENT 665,557

FOR HIGH PRODUCTION,
HIGH QUALITY STRAIGHTENING OF STEEL
OR NON-FERROUS TUBES AND PIPES



AVAILABLE IN
ALL SIZES FOR
5/16" TO 24" TUBES

Exclusive Features

MINIMUM TO MAXIMUM SIZE CHANGEOVER IN LESS THAN FIVE MINUTES.

CONTINUOUS STRAIGHTENING OF TUBES AND PIPES, WITH OR WITHOUT UPSET ENDS.

OPERATES WITHOUT GUIDES.

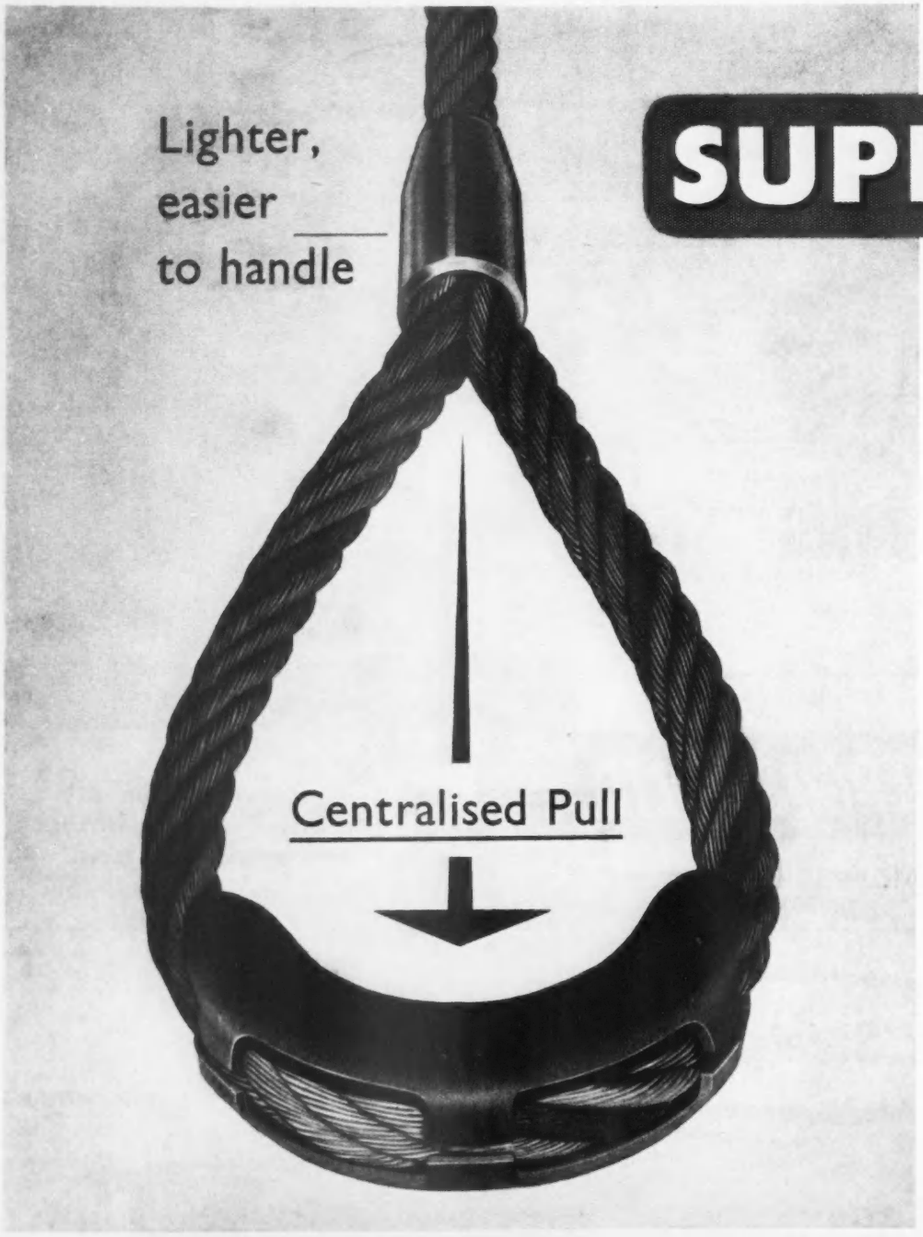
CAN BE IN LINE WITH TUBE MILL.

SPEEDS UP TO 800 FT. PER MINUTE.

NOW MANUFACTURED UNDER EXCLUSIVE LICENCE BY
FARMER NORTON

SIR JAMES FARMER NORTON & CO. LTD.

ADELPHI IRONWORKS, SALFORD 3, MANCHESTER
Telephone: Blackfriars 3613-4-5, 3692-3. Telegrams: "Agricola" Manchester.



SUPERLOOP

a slimmer, safer mechanical splice

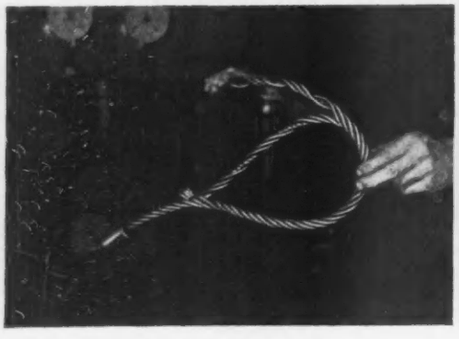
British Ropes Limited have evolved a new type of wire rope sleeve to overcome the drawbacks of other mechanical splices.

The main advantages of this new process, SUPERLOOP, are a safer mechanical splice, a slimmer sleeve, and a *true centre pull*. The sleeve, made of a specially approved steel, is closed over the tails of a Flemish Eye splice, making SUPERLOOP the lightest, slimmest and easiest to handle. It is at least as strong as a well made hand splice, and practical tests show it to be particularly ideal for the hard-worked sling. The smooth exterior of the sleeve, and its small dimensions mean that SUPERLOOP can be employed in many applications where more bulky hand and mechanical splices are impracticable. SUPERLOOP is concentric with the rope because of the Flemish Eye which is incorporated. A specially developed fitting, known as a SUPERLOOP STIRRUP, is available to protect the bearing of the eye from wear.

The development of SUPERLOOP was achieved only by intensive research and exhaustive tests backed by the wide knowledge and experience of the manufacturers.

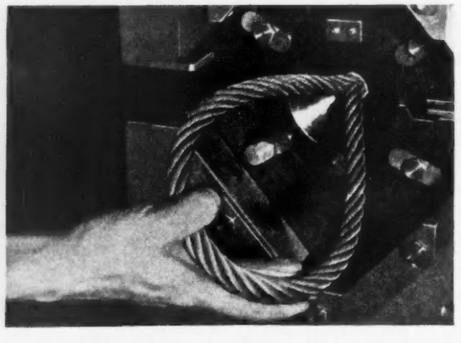
HANDS ARE SAFE WITH SUPERLOOP

During the six months' operational tests throughout the country, SUPERLOOP users report *complete freedom* from the hand injuries normally experienced with bare wire ends and broken wire servings.



FORMING THE LOOP
The secret of SUPERLOOP's true centre pull — a Flemish Eye is hand spliced and this alone gives a strength in excess of the Safe Working Load even before *the sleeve is fitted.*

FITTING THE SLEEVE
The steel sleeve is fitted neatly over the tails of the splice and is tapped into place entirely covering the wire ends.



PRESS CLOSES THE SLEEVE
Specially designed Dies permit comparatively low pressures to be used, eliminating any serious damage due to crushing.

SUPERLOOP in conjunction with Blue Strand Preformed Rope gives you the perfect sling.

Developed by **BRITISH ROPES LIMITED** *Doncaster*

Wire Rope Sales Offices at London, Liverpool, Birmingham, Glasgow, Cardiff, Gateshead, Hull, Southampton etc.

M·W·57

BARNES

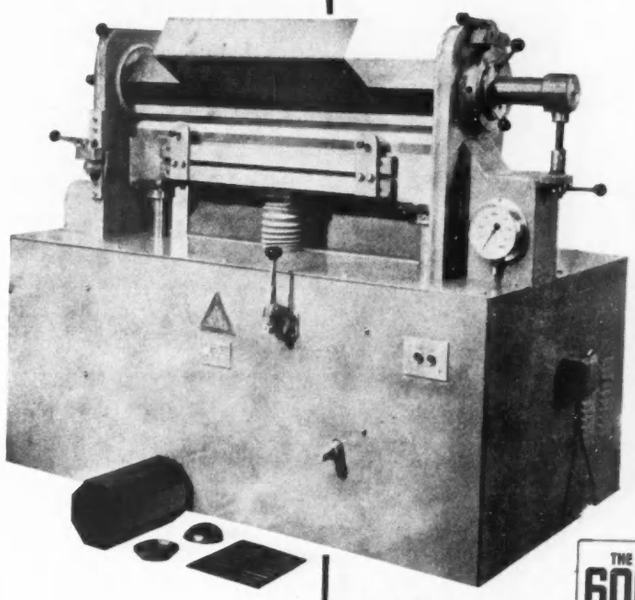
"SQUARE BEAM" HYDRAULIC UPSTROKING BENDING PRESSES

FOR A VARIETY OF BENDING, FOLDING & FORMING OPERATIONS WITH REQUISITE TOOLS

SPECIFICATION

Pressure variable up to 28 tons. Forming capacity in Mild Steel 4′ × $\frac{3}{16}$″. Stroke variable up to 8″. High Tensile Top Beam $4\frac{3}{4}$″ square. Self-Contained Hydraulic Unit Motorised 400 volt, 3 phase, 50 cycles.

One of our Technical Representatives will gladly visit you, on request, to discuss your problems.



BARNES 48″ × $\frac{3}{4}$″ m.s. "Square Beam" Hydraulic Upstroking Bending Press with hinged end housing

THE 600 GROUP OF COMPANIES

Sole World Agents

GEORGE COHEN

SONS AND COMPANY LIMITED

Sunbeam Road, North Acton, London, N.W.10.
Telephone : Elgar 7222/7

Stanningley, Nr. Leeds.
Telephone : Pudsey 2241

Kingsbury (Nr. Tamworth) · Manchester · Glasgow · Swansea · Newcastle-on-Tyne · Sheffield · Southampton · Belfast · Bath

Famous British Engineers came to BARIMAR in an emergency

BARIMAR takes it as a compliment when an engineering firm of high repute, and one of the biggest dollar-earners in Britain, calls upon Barimar for its Scientific Welding services. It is also a further tribute to that quick, efficient and inexpensive co-operation which has been at industry's command for over half a century.

This tremendous casting, nine and a half feet of cast iron, is the column of a gigantic steam hammer that came to grief without warning, bringing the output of a vital department to an abrupt and disturbing standstill. The first picture reveals the broken bolt holes at the top, and the damage to part of the keyway.

The problem was whether to transport this 4-ton casting several hundred miles by road to the Barimar Works, or to repair the job on the site. Being aware of the resources of the Barimar workshops and with past experience of Barimar's work, the owners decided to send it by road.

Within less than a week, the repaired and strengthened column was on its way back—back on the job of earning more dollars for Britain. Barimar's engineering friends were assured that the reinforced casting was "better than new", that the workmanship was fully vouched for, and that it was completely covered by the Barimar Money-Back Guarantee—so is *every* job of Barimar Scientific Welding, great and small.

Cast iron column of giant steam hammer, broken and useless. 9ft. 6ins. high, Weight : 4-tons.

IN LESS THAN A WEEK the column has been repaired and reinforced by BARIMAR under THEIR MONEY-BACK GUARANTEE

ACCIDENTS HAPPEN TO THE FINEST MACHINERY

Save time, money and anxiety by telephoning Barimar immediately. Their advice and experience is at your service—at any hour of the day or night.

Please remove fittings and consign all Transportable Parts, CARRIAGE PAID. Post instructions or order. When it is impossible to transport damaged machinery Barimar experts OPERATE ON THE SPOT.

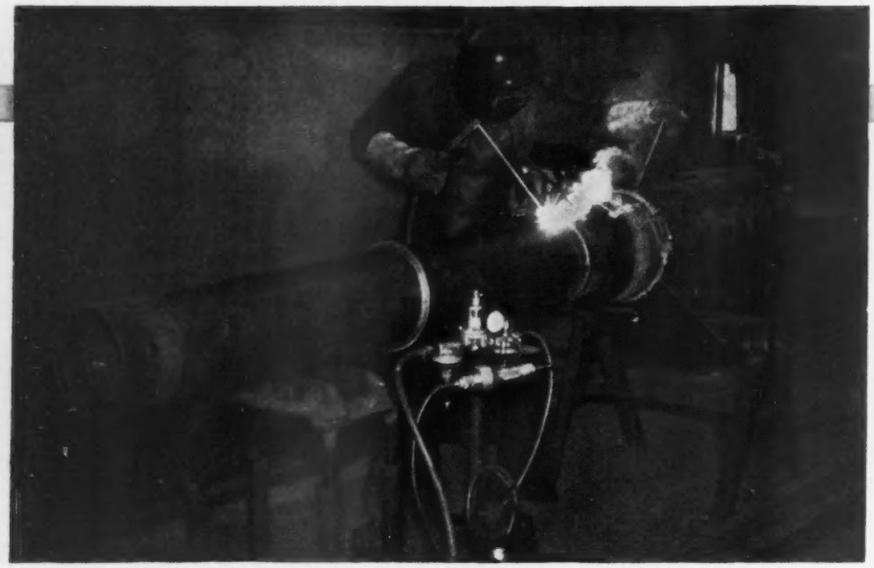
BARIMAR LTD.

Barimar House, 22-24, Peterborough Road, FULHAM, LONDON, S.W.6

Telephones: RENown 2147-2148. Night 2148 Telegrams: "Bariquamar, Walgreen, London."

BARIMAR BRANCH ADDRESSES : BIRMINGHAM 12 : 116-117, Charles Henry St. *Phone : Midland 2696.*
MANCHESTER 13 : 67, Brunswick St., Ardwick. *Phone : Ardwick 2738.* NEWCASTLE UPON TYNE : 64-66, The Close. *Phone : 21055.* GLASGOW C.2 : 134, West George Lane. *Phone : Central 4709.*

THE WORLD'S SCIENTIFIC WELDING ENGINEERS



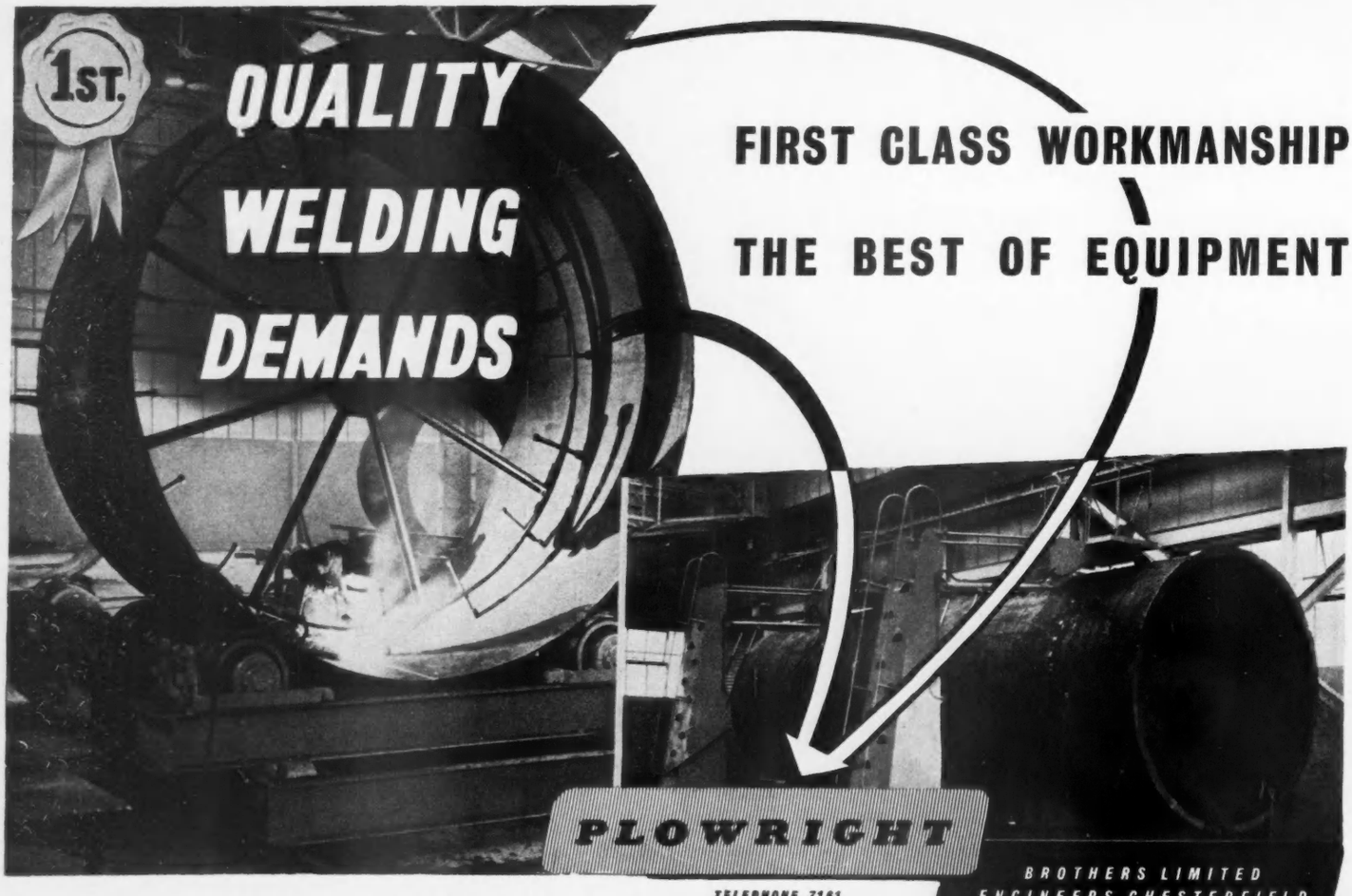
WELDING CHARGE TUBES

The photograph shows an operator welding one of the 448 charge tubes, using low hydrogen electrodes throughout.

The Unit Superheater and Pipe Co. Ltd., following initial contracts for reactor charge tubes for Calder Hall and Chapelcross power stations, has been entrusted by Whessoe Limited member company of the Nuclear Power Plant Co., to produce the charge/discharge and control rod stand tubes for Bradwell Power Station.

THE UNIT SUPERHEATER AND PIPE CO. LTD • UNIT WORKS SWANSEA. Telephone : Swansea 54091 (6 lines.) Telegrams : 'Superunits', Swansea. Telex : 48-208.

UNIT

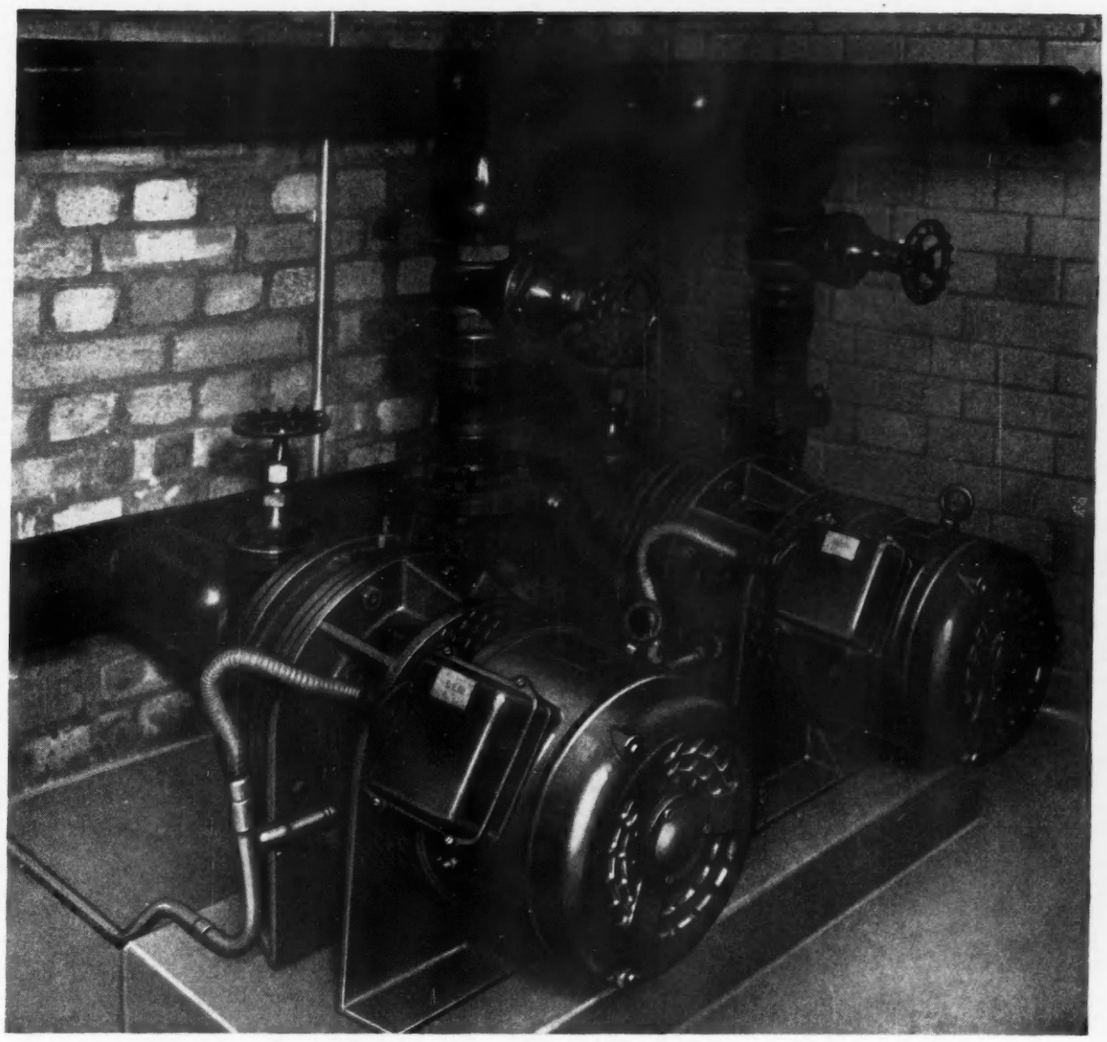


London Office: 40, Broadway, S.W.1. Tel: Trafalgar 2104

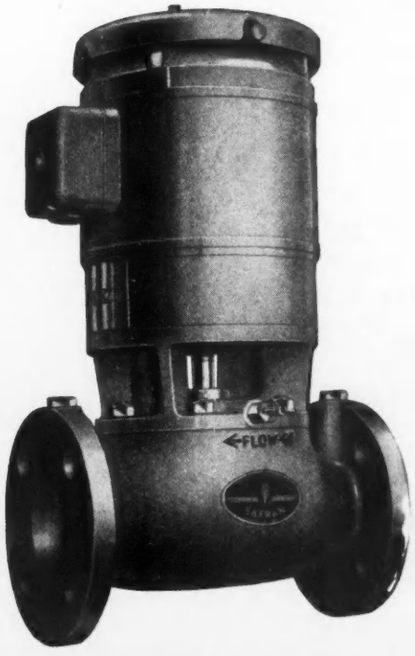
TELEPHONE 7181
TELEGRAMS 'PLOWRIGHT'

BROTHERS LIMITED
ENGINEERS CHESTERFIELD

PB 21



Pumpin', heatin' n' coolin'



Whether for Warnford Court in the heart of the City (as this installation by Messrs. M. & J. Lossos & Co. Ltd.)—for Tantivy Towers in the heights of Heythropshire, for the remotest lodge in Grousemoor or the busiest industrial application—there's no finer tackle than Safran Pumps.

SAFRAN
REGISTERED TRADE MARK
PUMPS

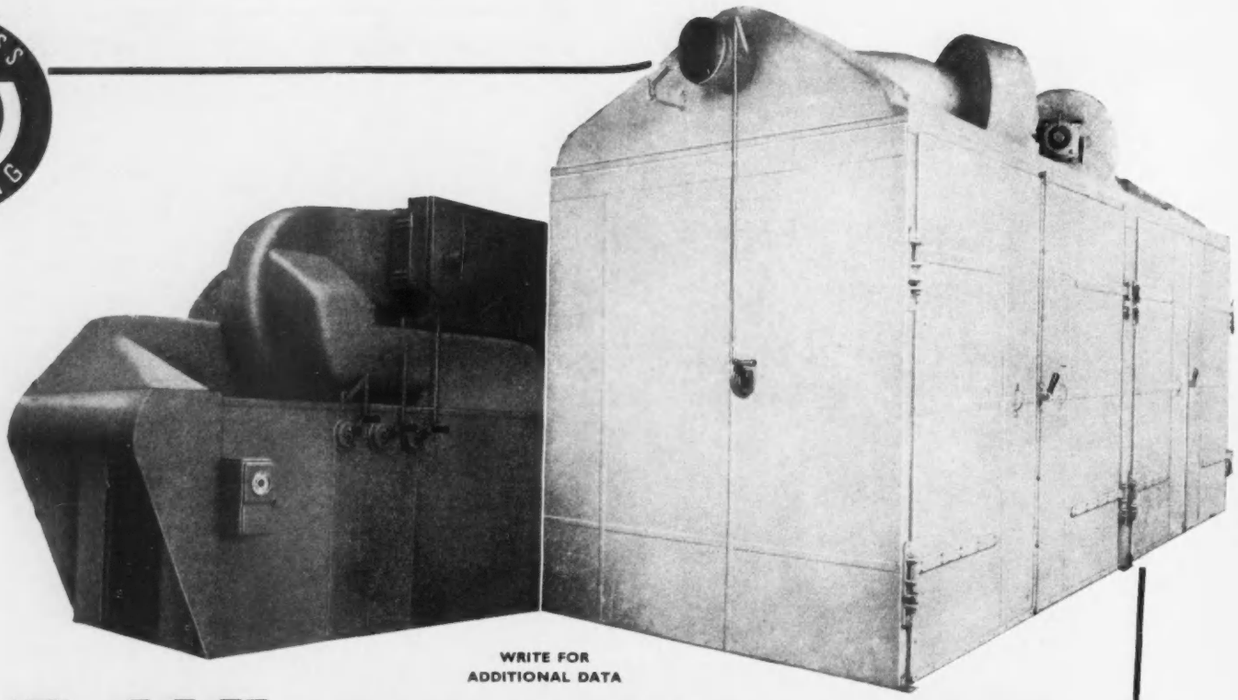
Illustrated (left) Safran Type C.C.E. Water Circulator Fullway-direct-in-pipeline design, allowing gravity circulation when desired. Sizes: 1½", 2" and 3".

(In large illustration) Two Self Contained UNISHAFT Electric Pumps with compact and accessible bulkhead mounting.

SAUNDERS VALVE COMPANY LIMITED

SAFRAN PUMP DIVISION

DRAYTON STREET - WOLVERHAMPTON



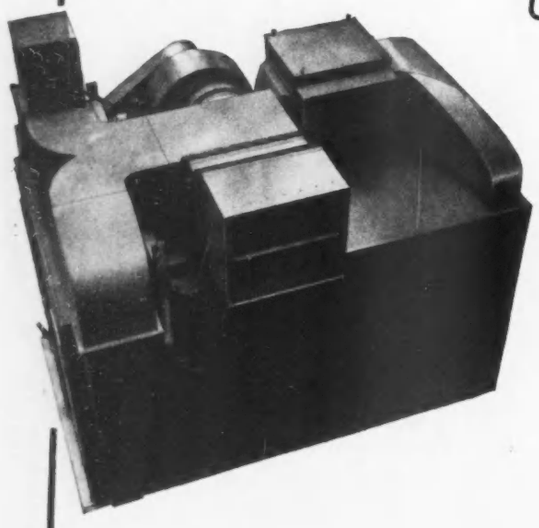
WRITE FOR ADDITIONAL DATA

'B-W' INDUSTRIAL OVENS

OVER 150 STANDARD MODELS

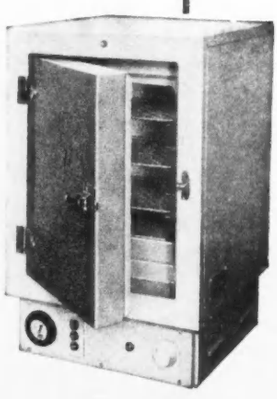
ELECTRIC . GAS · STEAM

UNUSUAL SHAPES & SIZES TO SPECIAL ORDER



Barlow-Whitney are acknowledged specialists in the production of Industrial Heating Equipment. Their standard range includes:

VACUUM IMPREGNATING PLANT · FURNACES · OIL AND GAS HEATERS TROPICAL CHAMBERS HUMIDITY CABINETS SALT AND SOLDER BATHS AND HOTPLATES



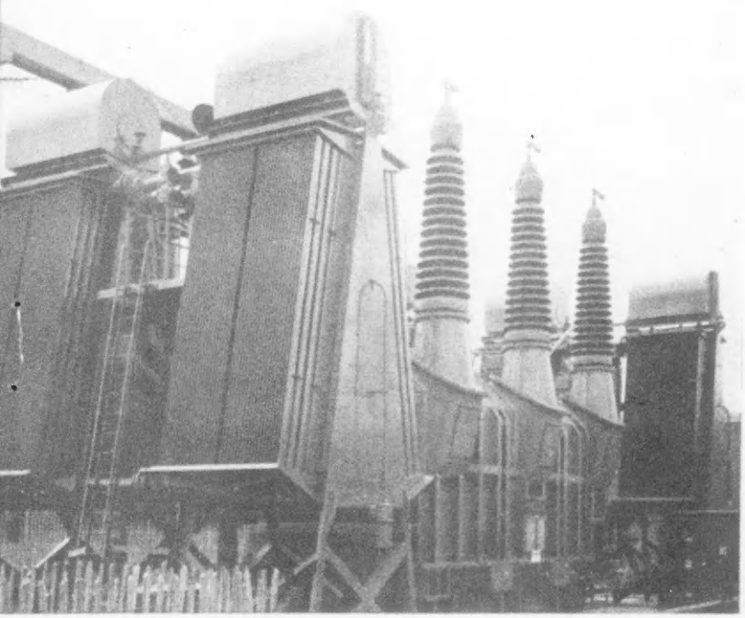
WRITE FOR OUR EQUIPMENT BROCHURE No. 5A

Barlow-Whitney LTD

BARLOW-WHITNEY LTD., 2, DORSET SQUARE, LONDON, N.W.1. TEL. AMBASSADOR 5485. WORKS: LONDON & BLETCHLEY

BMJ

. . . and yet another . . .



The first of three Parsons 120 MVA 3-phase auto-transformers en route to the C.E.G.B. North Western Division, Harker substation near Carlisle. Each of these transformers has a voltage ratio of 275/132 kV, voltage variations being achieved by on-load tap changing gear. In transit the transformer weighs 127.5 tons. On site, complete, including oil, 239 tons.

Several Parsons 120 MVA transformers are already in operation with C.E.G.B. on 132 kV and 275 kV grid systems.

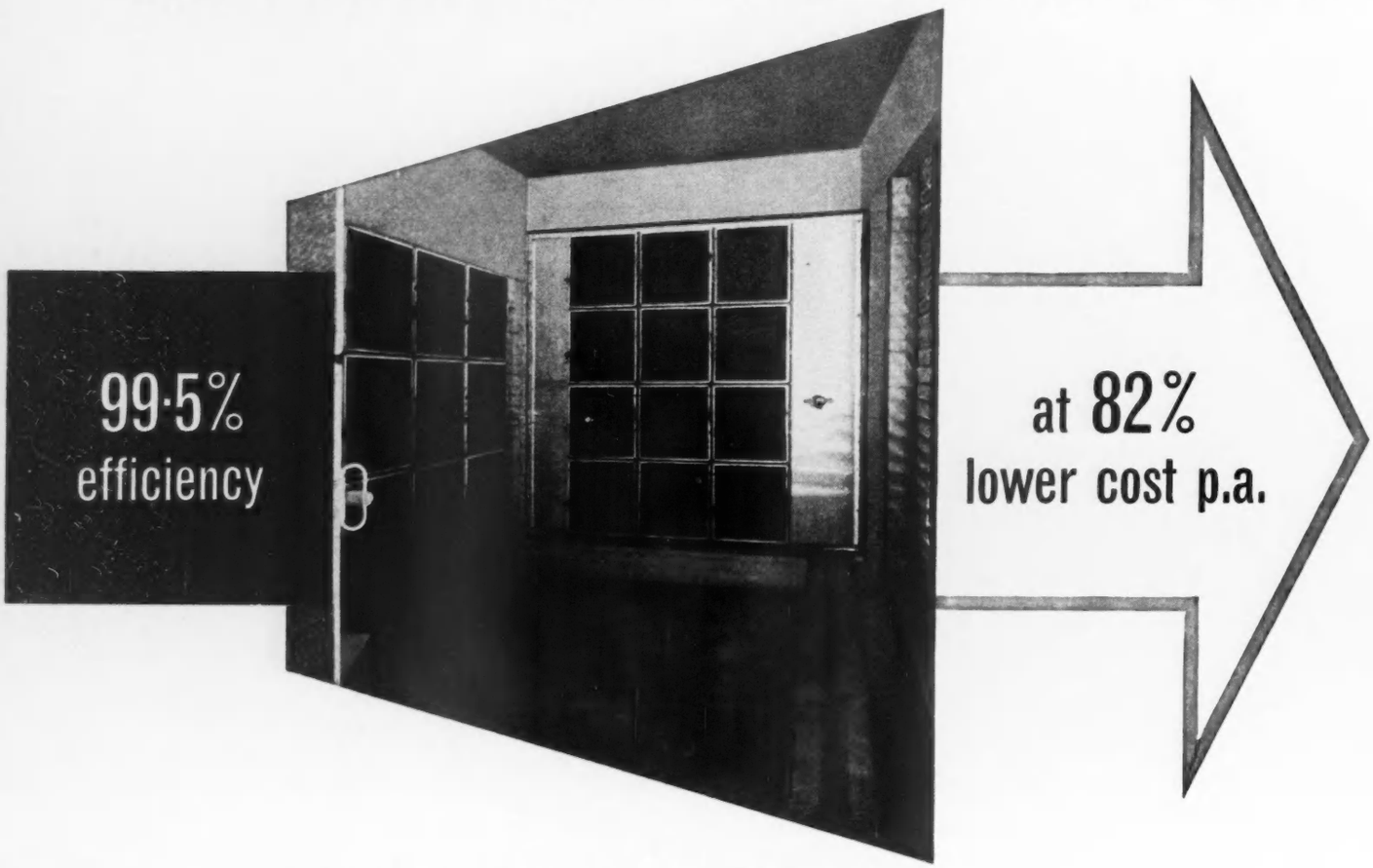
PARSONS

TRANSFORMERS

C. A. PARSONS & COMPANY LIMITED · HEATON WORKS · NEWCASTLE UPON TYNE 6

Far-Air filters

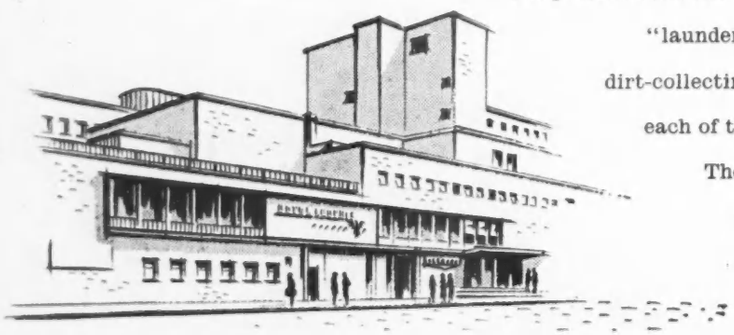
solve HOTEL LEOFRIC'S air cleaning problem



The original filters, which needed changing at 2-week intervals, allowed industrial fly-ash and smuts to get through.

The present FAR-AIR filters, which replaced them, are changed and "laundered" at 5- or 6-week intervals, while they are still within their dirt-collecting capacity. A FAR-AIR filter is changed in 15 seconds: each of the previous filters took 20 minutes to change.

The Hotel Leofric—air conditioned throughout—now obtains considerably cleaner air at considerably less cost.



for high efficiency at low cost . . .

interpose an INTERMIT

filter, strainer, or gauze

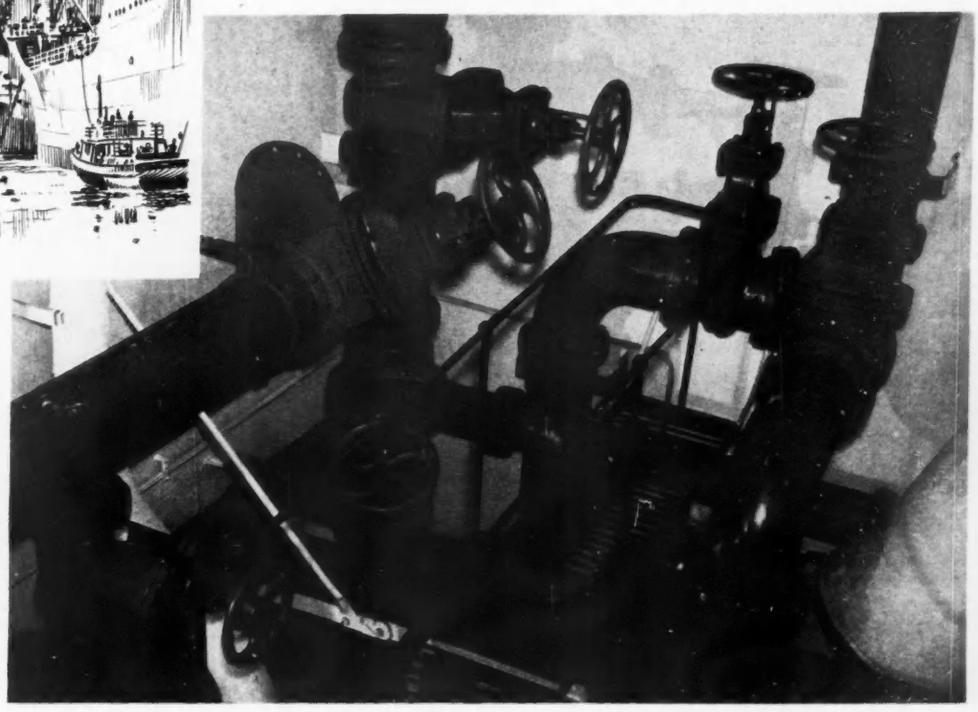
MEMBER OF THE BIRFIELD GROUP

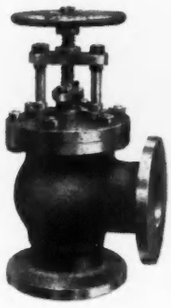
Enquiries to

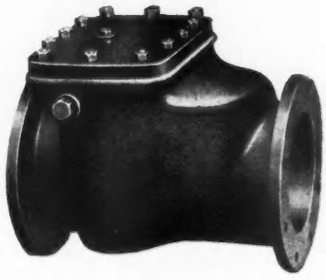
INTERMIT LIMITED · BRADFORD STREET · BIRMINGHAM 5 · PHONE: MIDLAND 7961

BIRFIELD INDUSTRIES LIMITED · LONDON · W.1

If it's VALVES







for Ships' Services

all requirements for valves to control the flow of fresh or sea water, or oil, in circulating water systems; bilge, ballast and domestic services; wash deck, oil fuel and tanker cargo lines, etc., can be readily met from the Glenfield valve range.

Illustrated are typical examples of sluice valves for water and oil, globe and non-return valves.

Glenfield

GLENFIELD & KENNEDY LIMITED KILMARNOCK

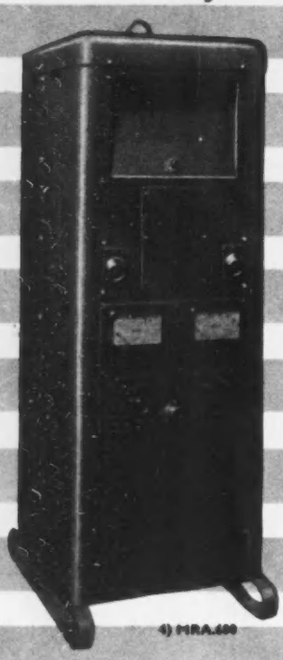
Head Office and Works:
KILMARNOCK · SCOTLAND

QUASI-ARC RECTIFIERS

1) MCR.450

2) MR.375

3) MRS.425



4) MRA.600

5) MRA.1200

6) MCR.375

1. 75-450 amps, with infinitely variable current control for manual welding.
2. 25-375 amps, with infinitely variable remote current control for manual welding.
3. 85-425 amps, with remote current control, specially designed for use with the SIGMA process.
4. 120-600 amps, continuously rated for use with automatic welding.
5. 240-1200 amps, continuously rated for use with heavy automatic welding.
6. 25-375 amps, of similar construction to the MCR.450.

All sets are built in accordance with B.S.638:1954 where applicable.

Quasi-Arc's comprehensive range of metal rectifier sets is the result of many years' experience in the design of this type of equipment.

Quasi-Arc · Fusarc · Fusarc/CO_2 · Unionmelt · Sigma

WHEN IT COMES TO WELDING

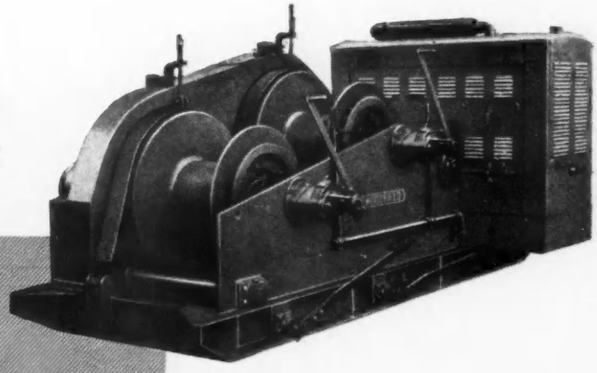
COME TO

QUASI-ARC

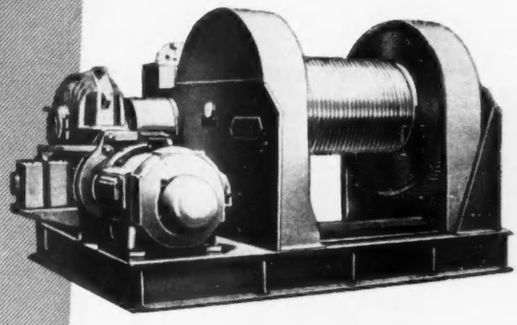
QUASI-ARC LIMITED · BILSTON · STAFFORDSHIRE

Consult WOODFIELD on your next winch problem

Woodfield 5-ton Double Drum Diesel Winches for Pile Driving, Derrick or general haulage duty.

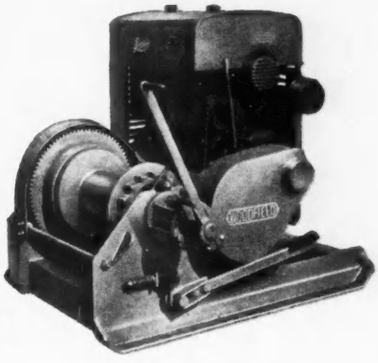


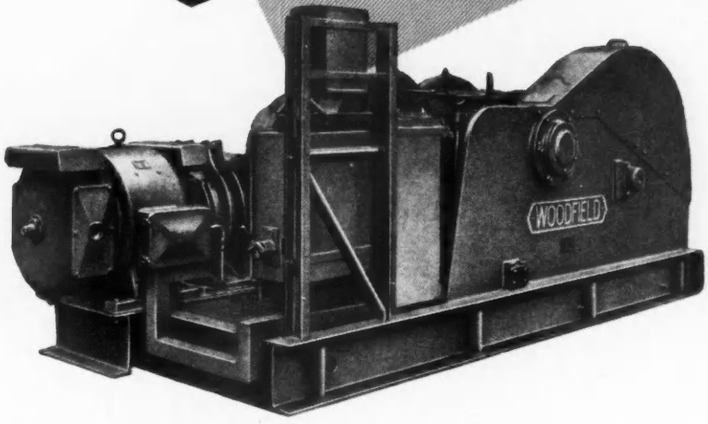
Woodfield electrically driven Slipway Winches. 58 H.P. motor geared to give 14.5 tons line pull.



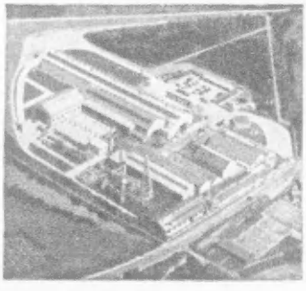
Woodfield special purpose winches for raising and lowering marine mineral boring tower. Driven by 45 H.P. electric motor, these winches have a line pull of 30 tons.

Woodfield diesel driven single drum hoists. Capacity 20 cwts., for general purposes.





WOODFIELD manufacture under licence the range of IDECO Oilfield Drilling Equipment



WOODFIELD HOIST & ASSOCIATED INDUSTRIES LTD.

Makers under Licence of IDECO Oilfield Equipment

Frindsbury Works · Rochester · England

Telephone: STROOD 78421 (5 lines) Telegrams: WOODFIELD-TELEX-ROCHESTER Telex: 89100 WOODFIELDSTROOD

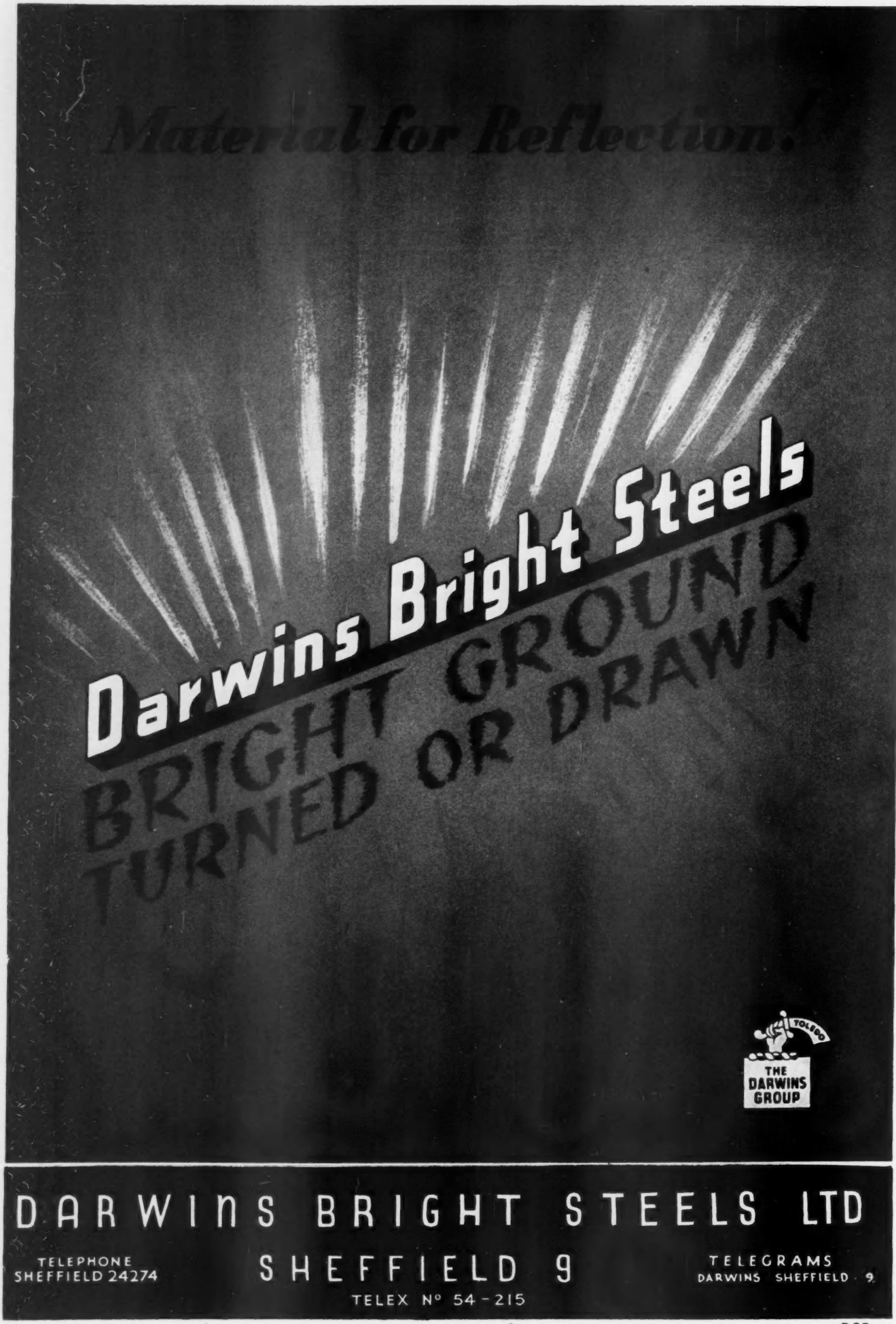
London Office: 147, Victoria Street, S.W.1

Telephone: TATe Gallery 4135 Telegraphic Address: Powerigs London

associating:

KEMWORTHY JIG & PRESS TOOL COMPANY LTD.
HIGH STREET, COLLIERS WOOD, LONDON, S.W.19.

R. H. CORBETT AND COMPANY LIMITED
HYDRUM WORKS, BURGESS HILL, SUSSEX


Material for Reflection!
Darwins Bright Steels
BRIGHT GROUND
TURNED OR DRAWN
TOLEDO
THE DARWINS GROUP
DARWINS BRIGHT STEELS LTD
TELEPHONE SHEFFIELD 24274
SHEFFIELD 9
TELEX Nº 54-215
TELEGRAMS DARWINS SHEFFIELD 9
D93

I gather Ransome & Marles have a substantial export trade?

Yes. Business overseas has been done for many years through agents and subsidiary companies. Among our biggest customers are many of the newly industrialised countries in Africa and the Far East—countries which are now equipping themselves with machinery at an enormous rate. We also export our bearings to the established industrial areas—to Europe and North America—where our products enjoy a long record of first-class service.

You have, of course, a worldwide network of agents to support this export trade?

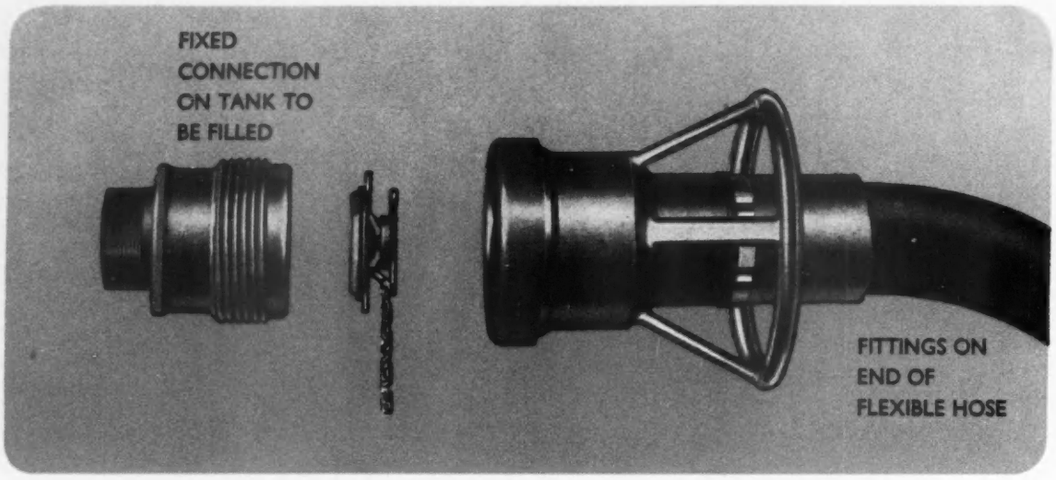
We have indeed. Something like eighty agency offices throughout the world. We are concerned, mainly, with providing an unrivalled on-the-spot service for overseas industry. Firstly, we produce bearings that will stand up to arduous conditions of work in every climate. Secondly, local users are thoroughly informed about all the factors affecting the actual running of the bearings. Thirdly, the purchaser is safeguarded with after-sales service. These are our obligations to the foreign manufacturer. I think it is fair to say that we meet them very successfully, because we are constantly expanding our export business and shall continue to do so in the future.

RANSOME & MARLES BEARING CO. LTD • NEWARK-ON-TRENT • ENGLAND

TELEPHONE · NEWARK 456 AND TELEX 37-306

BALL & ROLLER R&M BEARINGS

ON APPROVED LISTS OF THE ADMIRALTY, MINISTRY OF SUPPLY & AIR MINISTRY



Replenishes tank at pressure, is then disconnected without spillage

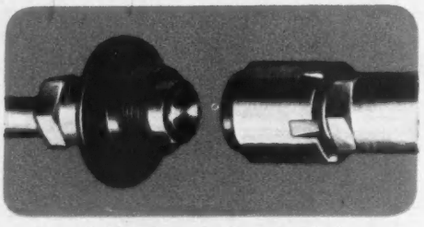
both fittings are self-sealing

MORE THAN A MILLION UNITS HAVE BEEN SUPPLIED

These couplings are self-sealing directly the couplings are disconnected; there is no spillage of the contents of the hose and no entrapping of air. The hoses are made in various qualities and sizes, some are available for very high pressure, fireproof when required, and they lend themselves to a great many applications for air and gases under pressure, for oil, fuel and hydraulic fluid.

They have been standardized for British Railways for refuelling diesel locomotives. Used in this way the couplings give the most efficient form of refuelling, being connected and disconnected in a fraction of a minute; there is no need to upend the hose and there is no loss of fuel.

Lockheed-Avery flexible pipes are made in a wide range of sizes and types. They are of high quality, ranging up to the special types used upon aircraft; they have easily detachable and reusable end fittings.



Self-sealing coupling detached from flange-type mating piece

The comprehensive catalogue of Lockheed - Avery flexible hoses, self-sealing couplings and pressure-replenishing connections for fuel, oil, etc. will be sent on application.

Lockheed Avery

Regd. Trade Mark

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, WARWICKSHIRE

ACRATORK

PRECISION TORQUE SPANNERS

- *Control torque application automatically*
- *Make overloading impossible*
- *Do not depend on the vision, care or skill of the operator for their accuracy*
- *Are unaffected by side loads*
- *Give precision results with unskilled labour*
- *Retain their accuracy for long periods of continuous use without attention*

Sixteen models provide for all loads up to 850 lbs./ft.

Also Hydraulic Torque Generators for loads up to 3,000 lbs./ft.

Test Rigs for all types of torque spanners.

World Distributors

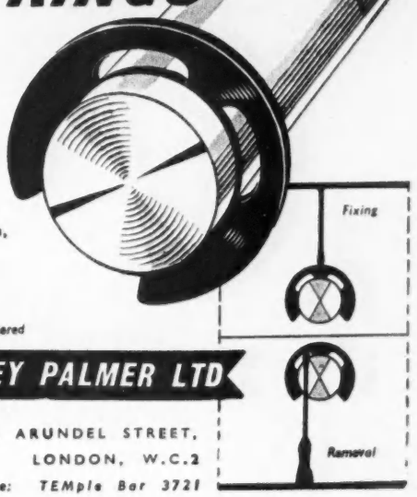
CORY BROTHERS & CO. LTD

DEPT. E., CORYS' BUILDINGS, CARDIFF Telephone: Cardiff 31141

Reducing production COSTS!

KLIKAX RETAINING RINGS

There is no better retaining ring than KLIKAX—the retaining ring made to precision limits and fine finish by special manufacturing technique.
For complete axial security, for easy assembly and pull-down, for low cost and production efficiency, you'll not improve on KLIKAX.

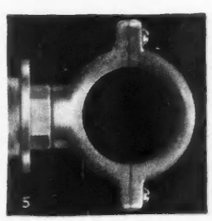


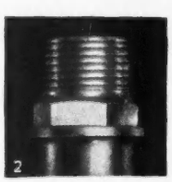
The name "KLIKAX" is registered

G · A · STANLEY PALMER LTD

MAXWELL HOUSE, ARUNDEL STREET,
LONDON, W.C.2
Telephone: TEMple Bar 3721

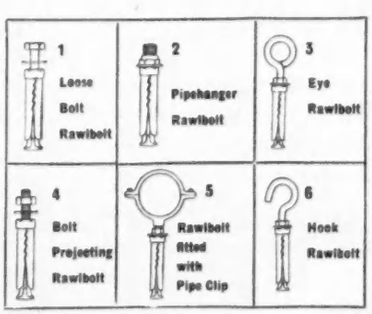
DsG449





You never need to improvise with Rawlbolts. There are types exactly right for every bolt-fixing job, No. 5, for example, for the support of pipework, and No. 2 for use with Pipe-hangers and other gas fittings. Hook and Eye Rawlbolts (Nos. 3 and 6) have many uses, such as providing anchorage for guy ropes and cables, supporting suspended ceilings, etc. There's the Loose Bolt Rawlbolt (No. 1), inserted after the machine is slid into position, and the Bolt Projecting Type (No. 4), ideal for wall-fixings. Rawlbolts give you bolt-fixings of enormous strength in a fraction of the time taken by any other method.

6 HEADS are better than one!



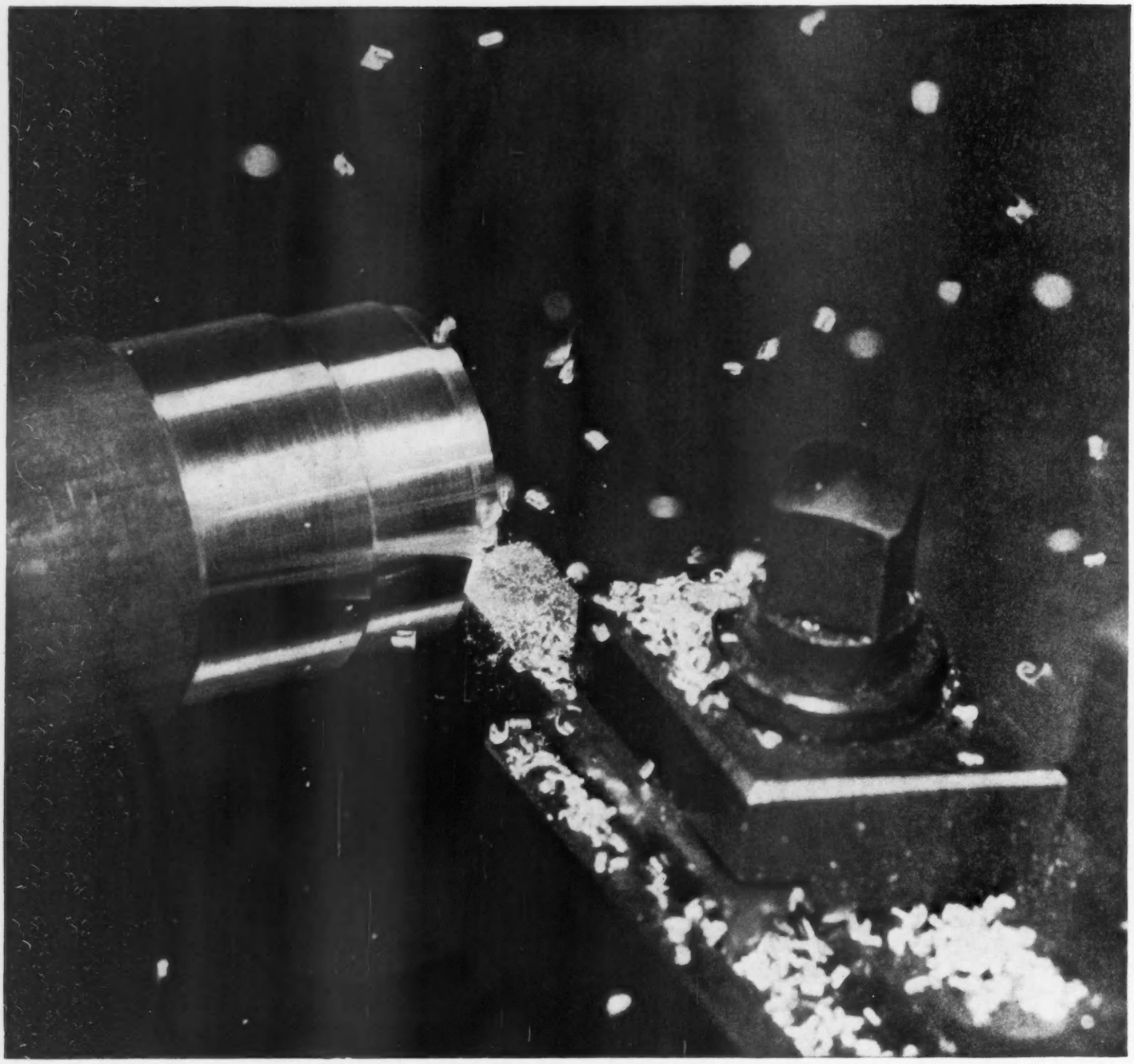
Every bolt-fixing job is far quicker with

RAWLBOLTS

RAWLPLUG

THE RAWLPLUG CO. LIMITED
CROMWELL ROAD · LONDON · S.W.7

B 580



Headstock speed 610 r.p.m., Traverse .005 in. per rev., Depth of cut .05 in. using tool with no rake. Photo taken with high speed electronic flash at 1/5000 sec. and f.16.

Duralumin 'C' machines like this

This photograph shows the results obtained from our aluminium alloy, Duralumin 'C'. This new addition to our range of light alloys has been developed specially for its outstanding machining properties. Already this alloy is meeting with remarkable success.

Our Technical Sales department will gladly put you in the picture if you contact us. You will incur no obligation whatever.

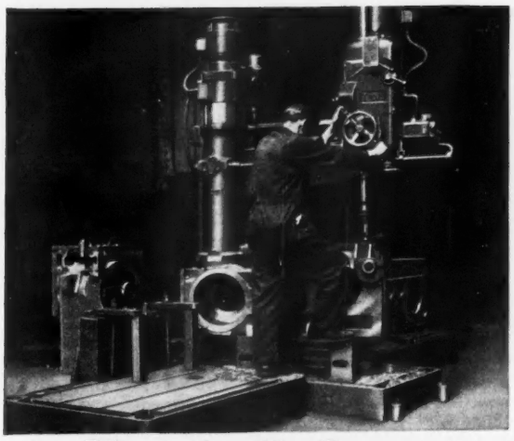
James Booth

JAMES BOOTH & CO. LTD., ARGYLE ST. WORKS, BIRMINGHAM 7

Extrusions, large forgings, plate, sheet, strip, tubes and wire in brass and copper, as well as light alloys Duralumin, Dural, Aldural, Simgal, MG2, MG3, MG5 and MG7 are our Registered Trade Marks.

TGA JGB 116A

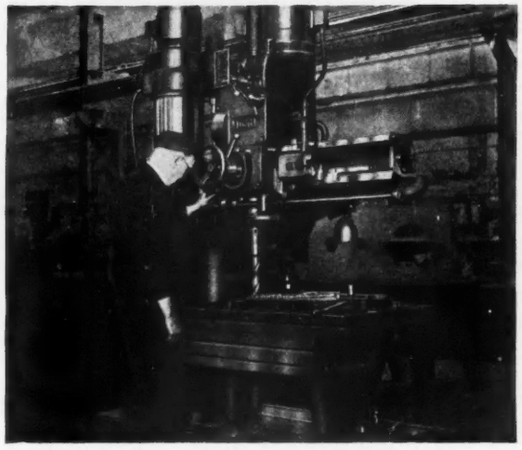
they go to Town...*



In the production line, this A.E.I. type Radial is drilling and tapping ⅝in. B.S.F. and 1in. B.S.P. holes in a Crawler Tractor gear box. Three-way base-plate set-up uses machine to its maximum capacity.

at Marshall Sons and Co. Ltd.

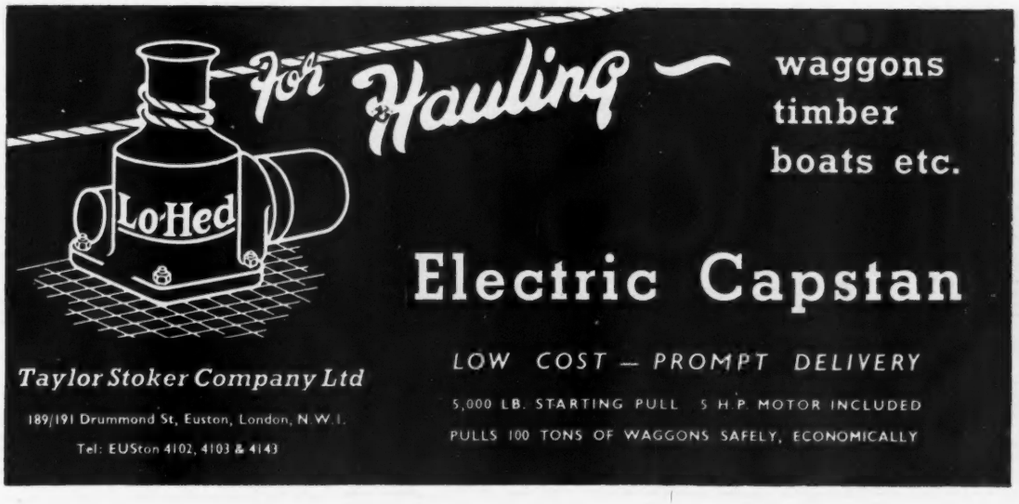
GAINSBOROUGH — LINC



In the toolroom, an A.E.I. type Radial is used for accurate work, in this case drilling a jig plate, the holes having been plotted previously on a jig-boring machine.

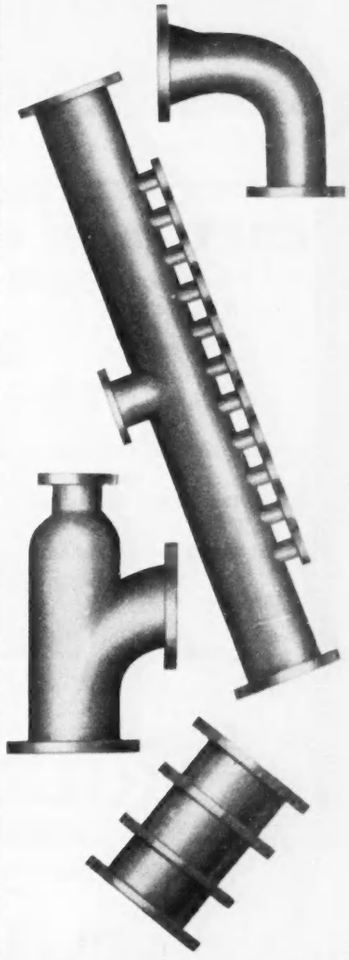
* ESTABLISHED · 1903
FRED^K TOWN & SONS LTD
HALIFAX · YORKS

TII


For Hauling — waggons timber boats etc.
Lo-Hed
Electric Capstan
LOW COST — PROMPT DELIVERY
5,000 LB. STARTING PULL 5 H.P. MOTOR INCLUDED
PULLS 100 TONS OF WAGGONS SAFELY, ECONOMICALLY
Taylor Stoker Company Ltd
189/191 Drummond St, Euston, London, N.W.1.
Tel: EUSton 4102, 4103 & 4143

Pipework Specialists

For over 110 years we have specialized in the manufacture of CAST IRON PIPES AND FITTINGS



We also specialize in the Fabrication and **Installation** of all types of pipework including non-ferrous metals

SHAW AND McINNES LIMITED

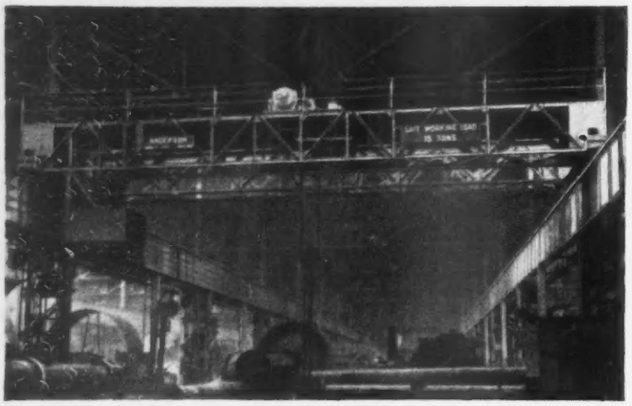
FIRHILL IRONWORKS, GLASGOW, N.W.
Maryhill 1175-6-7

28 Kennedy Street Manchester, 1
Central 6341

332 High Holborn London, W.C.1
Chancery 3378-3907

ANDERSON Electric Overhead Cranes

★ RUGGED ★ RELIABLE ★ ECONOMICAL



15-ton E.O.T. Crane x 48 ft. span

Some Further Exclusive Features :

- LOW MAINTENANCE
- ACCESSIBILITY
- SUPERIOR VISIBILITY
- INTERCHANGEABLE SPARES
- DEPENDABLE ON ALL OCCASIONS

London Office: Finsbury Pavement House, E.C.2. *Tel : MONarch 4629*

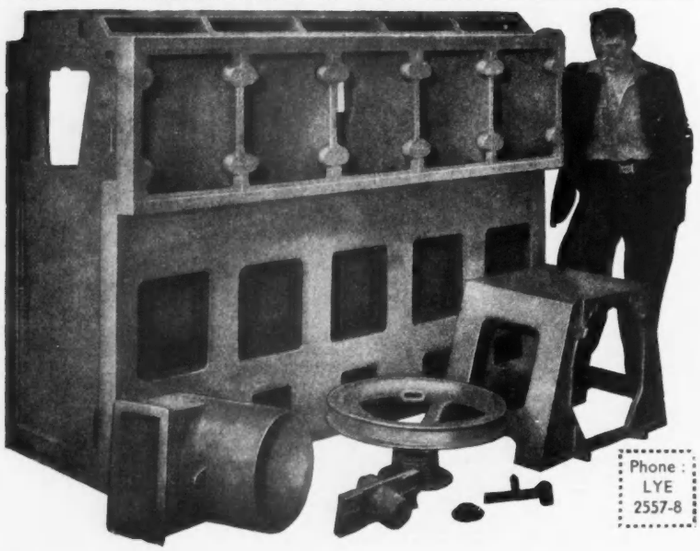
ANDERSON

THE ANDERSON-GRICE CO. LTD.
TAYMOUTH ENGINEERING WORKS, CARNOUSTIE, SCOTLAND

Telephone : Carnoustie 2214/5. Grams : "DIAMOND," CARNOUSTIE

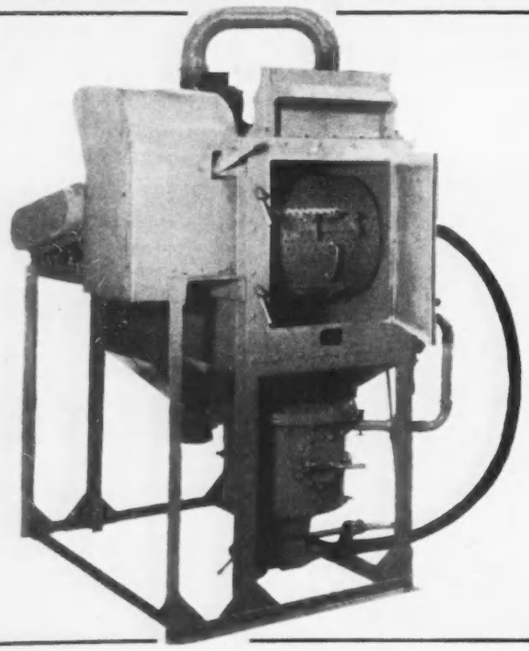
GREY IRON CASTINGS *from 2 OUNCES to* 15 TONS

In the production of Grey Iron Castings we have concentrated on these four vital points: accurate moulding to specification; unvarying quality throughout the run; clear finish and excellent machining surfaces; competitive prices. We shall be pleased to advise you on any particular castings problem. Our long experience is at your service.



Phone : LYE 2557-8

S. MOLE & SONS (GREEN LANE FOUNDRY) LTD. BOTT LANE · LYE · STOURBRIDGE · WORCS.



SHOT BLAST BARREL

COMBINED WITH FABRIC SCREEN FILTER FOR DUST REMOVAL, FAN AND ABRASIVE CLEANER.

ALL ABOVE FLOOR LEVEL.

FAN AND BARREL ARE INDEPENDENTLY MOTOR DRIVEN SO THAT FAN CAN RUN CONSTANTLY.

FOR CLEANING SMALL AND MEDIUM SIZE CASTINGS, FORGINGS, PRESSINGS, STAMPINGS, ETC.

SIZES

NO.	BARREL LENGTH	DIA.
1	INCHES 18	18
2	INCHES 24	18

SEND YOUR SHOT BLAST PROBLEMS TO

J. W. JACKMAN & COMPANY LTD.

VULCAN WORKS, BLACKFRIARS ROAD, MANCHESTER, 3.

TELEPHONE: DEANSGATE 4648-9. TELEGRAMS: BLAST, MANCHESTER.

ENGINEERS' MARKING-OFF TABLES

All standard sizes up to 8′ 0″ x 4′ 0″

CAMEL BACK CAST-IRON STRAIGHT EDGES

3′ 0″—4′ 0″—6′ 0″

A. B. MILLER & CO.

77, DACE ROAD, LONDON, E.3.

Telephone: AMHERST 4407

offer prompt delivery and keen prices for their range of Foundry and Machine Shop Products

ENGINEERS' SURFACE PLATES

10″ x 10″ up to 2′ 6″ x 2′ 0″

GENERAL IRON CASTINGS

Up to 30 cwt.

Wood and Metal Patterns

HEAVY DUTY TEE SLOTTED WELDING PLATENS

6′ 0″ x 3′ 0″ and 8′ 0″ x 4′ 0″

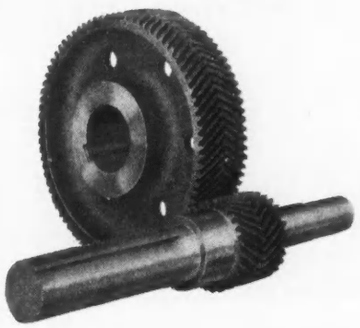
Other sizes to special order.

PLANING up to 12′ 0″ x 4′ 0″
GENERAL MACHINING
ARC WELDING · MACHINE PROFILE CUTTING

Makers of the "MILLER" Box Nailer and Cleater

BIRD'S

DOUBLE HELICAL AND OTHER TYPES OF GEARS



W. H. BIRD & SONS LTD.
ST. PHILIPS, BRISTOL 2.
'Phone: BRISTOL 77033.
Grams: Oiseau, Bristol.

GEARS Bristol

Vanguard

First in the Line

Vanguard valves and pipeline fittings, specially designed and manufactured for the oil, petro-chemical, atomic energy, pharmaceutical and related industries.

The range available includes:—

- Stop, Swing Check Valves, 'Y' Pipeline Strainers in Cast Carbon Steel, trimmed to requirements.
- Wedge Gate, Stop, Swing, Check Valves, 'Y' Pipeline Strainers, Flanges, Elbows, Tees, Unions, Pipeline Fittings in Stainless Steel.
- Tees, Elbows, Crosses, Unions, etc., in Forged Carbon Steel.

All valves and fittings conform to the latest British and American Specifications.

Write for illustrated literature to Dept. E.

THE VANGUARD VALVE COMPANY LTD.
Triplex Works · Eastern Avenue · Gloucester
Tel: Gloucester 26211

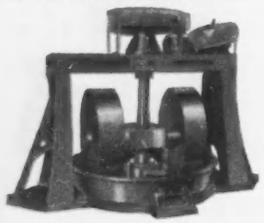
BRITISH SPRINGS AND WASHERS

WILLIAM FINUCANE
(Springs and Pressings)
LTD.

A.I.D. A.R.B.

ELGAR 3757/8/9
16A, HILLSIDE, STONEBRIDGE PARK, LONDON, N.W.10

TRADE Smedley MARK
PAN GRINDING MILLS



REVOLVING OR STATIONARY PANS
PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN

Smedley Brothers. Ltd.,
Belper. Derbyshire.
Telephone: Belper 12

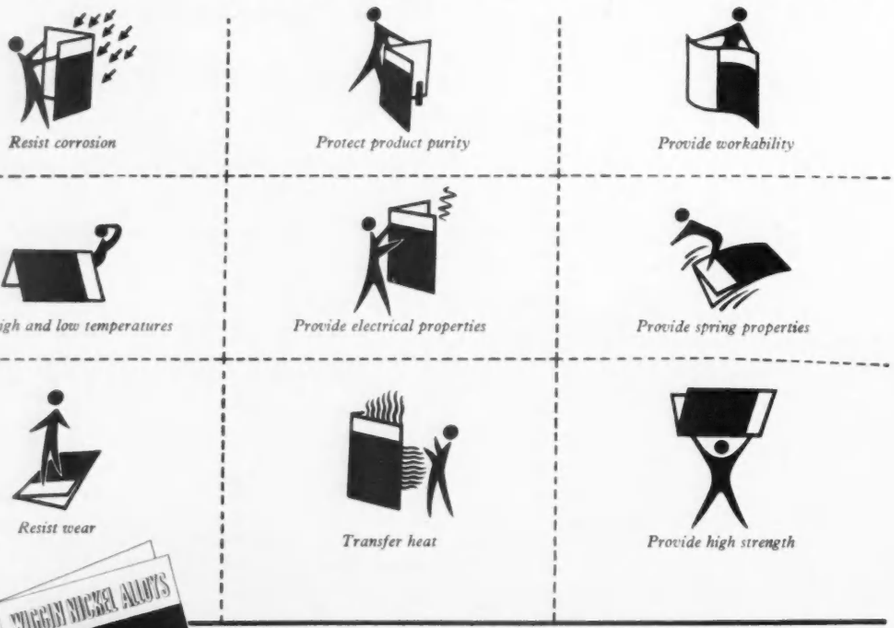
STEEL FRAME BUILDINGS
OF EVERY DESCRIPTION
Factories, Sheds, Mill Buildings, Foundries, Bungalows, Etc.
SPECIALITIES
Pit Headgear, Pumping Stations, Power Stations.
Bridgework and Riveted Work of all descriptions
BROWNLIE and MURRAY LTD.
POSSIL PARK, GLASGOW
LONDON: 32, QUEEN VICTORIA ST., E.C.4.

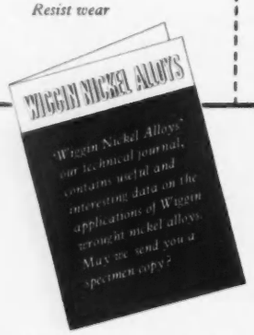
BRETT
DROP FORGING EQUIPMENT

BRETT'S PATENT LIFTER Co LTD
FOLESHILL WORKS, COVENTRY

How to select the right alloy

It would be easy to select the best material for a piece of plant or equipment if only one property had to be considered. But this seldom happens when a metal is required to withstand some unusually destructive combination of conditions. Usually the metal must be selected with the most suitable combination of the essential properties. Very often the choice will lie among the range of Wiggin wrought High-Nickel Alloys.
Our technical publications, containing comprehensive data on the properties and established uses of the Wiggin alloys, will gladly be sent on request. If you need expert advice, the Wiggin Technical Service can help you to solve material problems.




WIGGIN NICKEL ALLOYS
"Wiggin Nickel Alloys", our technical journal, contains useful and interesting data on the applications of Wiggin wrought nickel alloys. May we send you a specimen copy?

WIGGIN
***KNOW* NICKEL ALLOYS**

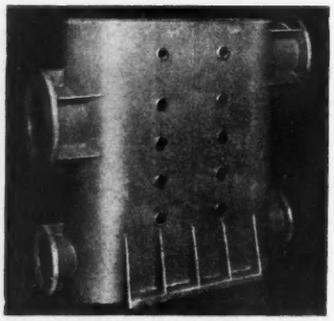
HENRY WIGGIN & COMPANY LIMITED · WIGGIN STREET · BIRMINGHAM 16
TGA MT4

PRIEST FURNACES

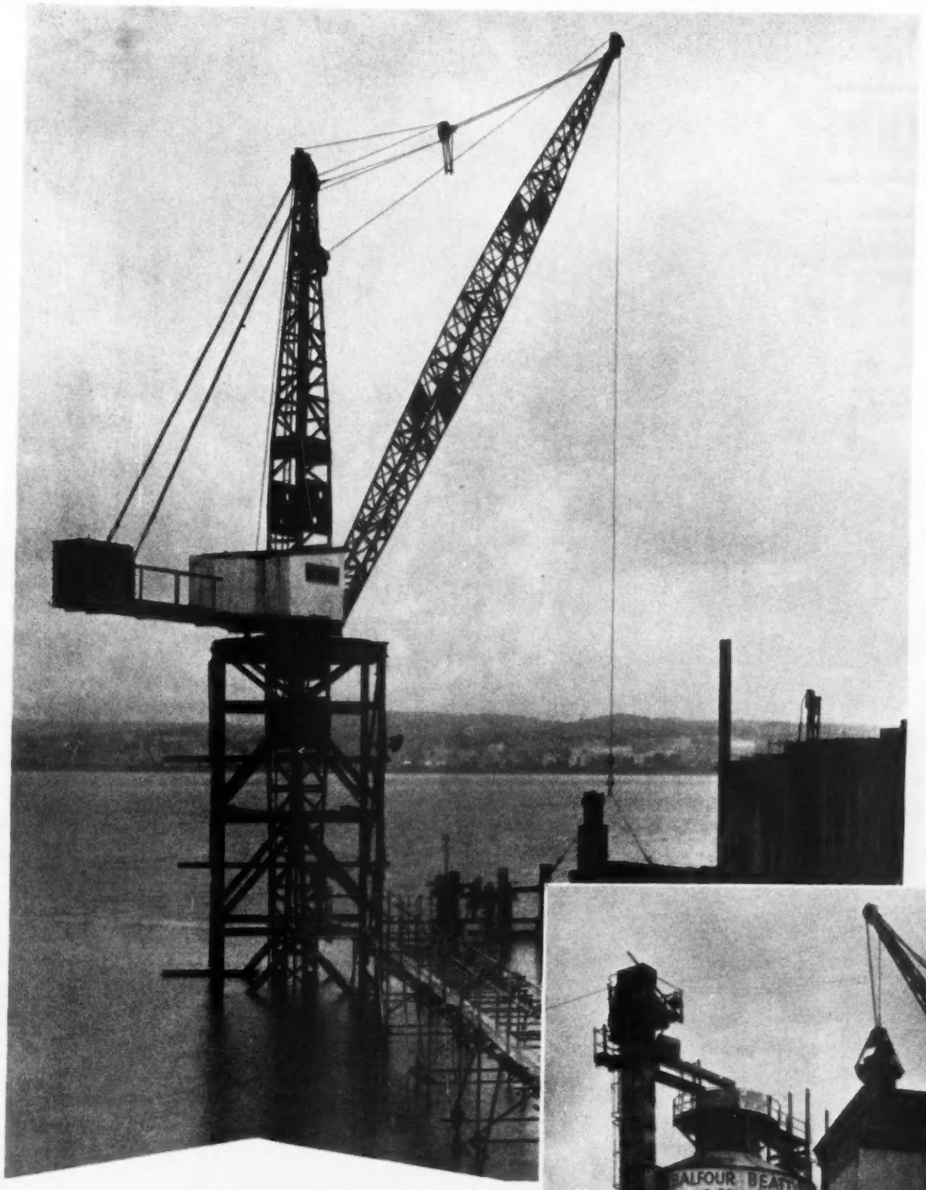
PRIEST FURNACES LIMITED
LONGLANDS
MIDDLESBROUGH

recognised everywhere as the most advanced practice

F.62



RICHMOND WELDING CO.
Fabrications Large and Small. Stainless Steel. Copper and Aluminium Welded by the Argon Arc or the Argonaut Process. Engineering.
Tel: BRADFORD 25405
Established 1929



Building AT *Berkeley*

a considerable number of
Butters Cranes
are in use at the new
nuclear power station

Building cofferdams in connection with tunnelling for circulating water intakes . . .

a BUTTERS MONOTOWER CRANE in service

This is a 7 ton model with a 100 ft. jib.
The full load is lifted at 75 ft. radius.

Loading aggregate in weighbatching plant . . .

a BUTTERS DERRICK CRANE in use

An electric two motor grabbing crane

These cranes are owned by Messrs. Balfour Beatty & Co. Ltd.

In addition to these several other Butters Cranes are in use at Berkeley, including four 15 ton Monotower Cranes which are being used in the erection of the reactors.

BUTTERS BROS. & CO. LTD., MACLELLAN STREET, GLASGOW, S.1

London : The Crane Works, Long Lane, Hillingdon, Middlesex.
Birmingham : County Chambers, Corporation Street. Newcastle : 65, Quayside.

US RUBBER EXPANSION JOINTS

This rubber joint holds water on the world's largest ships

Flexible rubber expansion joints are used on the largest ships afloat . . . (the giant 85,000-ton tankers Universe Commander and Universe Leader, the mighty aircraft carriers Saratoga and Forrestal). They are used on the water circuits of these ships—on the injection and discharge lines of the condensers and on the connecting pump lines. What they do is *absorb movement and shock, insulate against vibration and noise, prevent stresses due to expansion and contraction,* and eliminate corrosion by electrolysis of bolts, joints and piping.

U.S. Expansion Joints of the spool type, which can be used on most kinds of pressure or vacuum lines—afloat or ashore—are now in greatly increased production. Because they have proved so outstandingly successful they are now specified wherever there is a 'difficult' problem—in factories, public buildings, power plants, paper mills . . . in waterworks, sewage systems, mines . . . on ships. Light in weight, easy to install, designed to cope with high working pressures, U.S. Expansion Joints are the complete answer for piping systems and equipment, new and old. Write for specifications.

US RUBBER **U. S. Rubber**

Home: *The North British Rubber Company Limited. ABBey 7135*
Export: *U.S. Rubber International (Great Britain) Ltd. ABBey 2053*

62/64 HORSEFERRY ROAD, LONDON, S.W.1

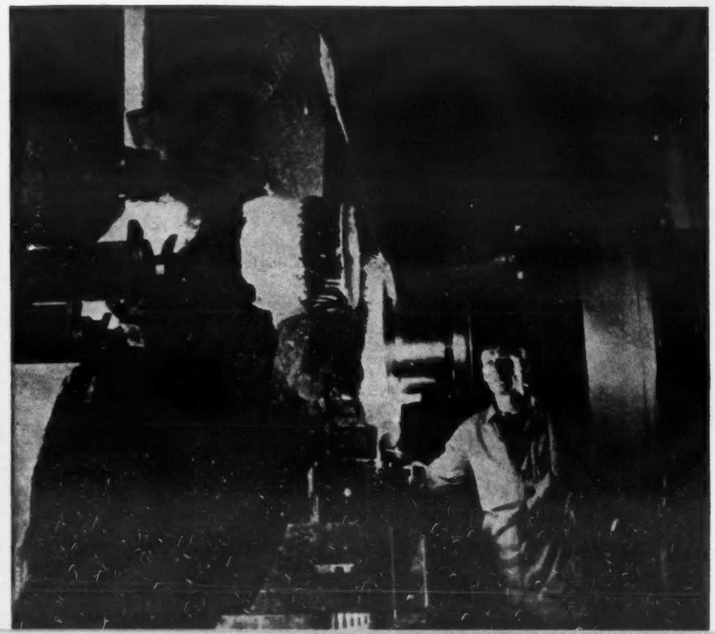
NEWTON CHAMBERS

Ironfounders to Britain's leading industries

Newton Chambers offer a complete foundry service from pattern making to machining and fitting, able to meet the needs of Britain's leading industries. The ironfoundry produces shell moulded castings and castings in green sand and dry sand, and in loam, by mechanised or floor methods.

Our light and heavy mechanised foundries have immediate production capacity for anything from one-off items to repetitive castings of a few pounds up to 20-tons, in grey iron or special alloy irons.

Please write for details about how Newton Chambers ironfoundry service can help you.



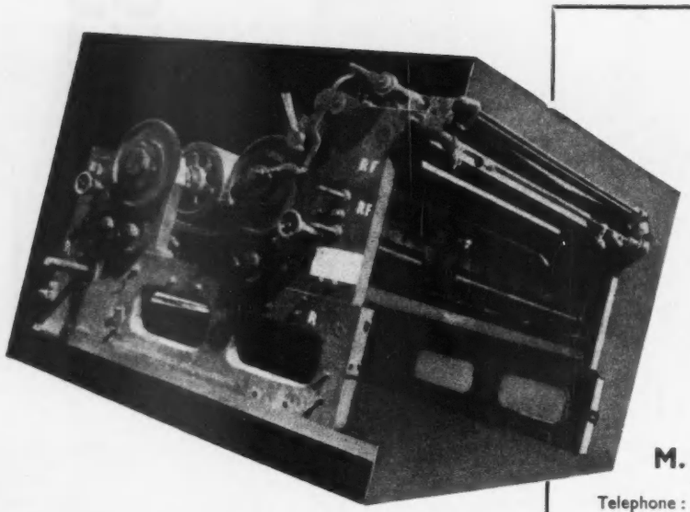
ENGINEERS OF PROGRESS

Newton Chambers

ENGINEERING DIVISION

NEWTON CHAMBERS AND COMPANY LIMITED
THORNCLIFFE, SHEFFIELD

34518



PACKED
for
EXPORT
by
SPECIALISED
STAFF

M.I.L. SERVICE

Telephone :
BIRMINGHAM MIDLAND 5731 P.B.E.
CARDIFF 25471 GLASGOW CITY 6597
NEWCASTLE UPON TYNE 22336

MACHINERY INSTALLATIONS LIMITED
60a HIGH ST · ACTON · LONDON W.3. · ACORN 6044 P.B.E.

TRANSPORT · ERECT and DISMANTLE ALL TYPES OF MACHINERY · BOILERS and CHIMNEYS Etc.

1,900,000!

POUNDS OF STEAM PER HOUR

YARROW and CO., LTD.

is to supply the Central Electricity Generating Board with

TWO 275 MW BOILERS

for

a projected power station at Blyth, Northumberland

These units will be of the controlled circulation type designed in collaboration with Messrs. International Combustion Ltd. Each boiler having an evaporation of 1,900,000 pounds of steam per hour at a pressure of 2,400 pounds per square inch and a final steam temperature of 1055°F with reheater to 1055°F

YARROW AND COMPANY LIMITED, SCOTSTOUN, GLASGOW

What's the big idea—shinning up here like a giddy monkey?

Take a look below, old chap.

Good heavens! Where did *that* come from?

Well there's only one place where they breed 'em that size . . .

It's a knockout, 'pon my word!

No old man, 'pon the Chesterfield press—the biggest and most powerful hydraulic piercing press in Britain.

Chesterfield Tubes

Chesterfield's 5,000 ton piercing press knocks out the heaviest of heavyweights in one punch. The hot drawn seamless tube illustrated is a section of a steel steam pipe supplied to one of Britain's largest power stations. Dimensions, 16 ins. bore x 24 ft. long.

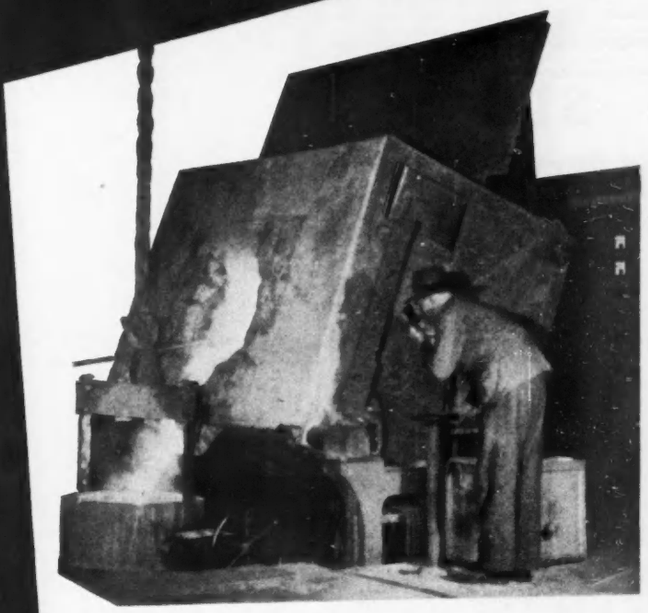
THE BIG GAME OF THE TI GROUP

THE CHESTERFIELD TUBE COMPANY LIMITED
CHESTERFIELD · ENGLAND

CRC 51

DEW

DEUTSCHE EDELSTAHLWERKE
AKTIENGESELLSCHAFT
KREFELD (GERMANY)



MARATHON
FINE STEELS
A.I.D. APPROVED

HIGH SPEED STEEL
TOOL STEEL
STAINLESS STEEL
HEAT RESISTANT STEEL
ALLOY STEEL
FINE STEEL CASTINGS
WELDING ELECTRODES
MAGNETS AND MAGNET SYSTEMS
HARD METAL TITANIT

AGENTS FOR GREAT BRITAIN:
MARATHON FINE STEELS LTD.,
ABBEY HOUSE, 2-8 VICTORIA STREET,
LONDON, S. W. 1
CABLES: MARAFINE SOWEST LONDON
TELEPHONE: ABBEY 1150

D

Specify MICHELL AND MAKE SURE OF YOUR BEARING

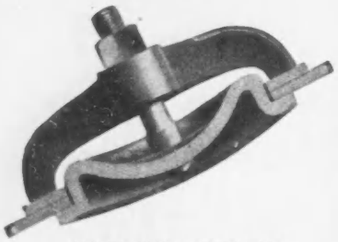
THEY SET THE COURSE FOR RELIABILITY

FOR Turbine Thrusts, Pedestal Bearings, Hydro-Electric Installations, Motors, Generators, Paper Making and Extruding Machines, Pumps, Fans, Etc., Etc.

MICHELL BEARINGS LTD
SOUTH BENWELL
NEWCASTLE upon TYNE, 5
Telegrams: MICHBEARO. Telephone: 3427

STONE BREAKERS
CRUSHING ROLLS
SCREENS
ELEVATORS and
CONVEYORS
Makers
R. BROADBENT & SON, LTD.
STALYBRIDGE

McNEIL
manhole doors
for air-receivers,
boilers, etc.



HEAVY STEEL PRESSINGS
FOUNDRY LADLES
FABRICATED STEELWORK
WELDED CENTRAL
HEATING BOILERS

CHARLES McNEIL LIMITED
KINNING PARK HYDRAULIC FORGE
570 SCOTLAND STREET, GLASGOW, S.1.
Grams: "McNeil, Glasgow" Phone: South 1131

It's high time
we saw the
G.E.C.
about
water heating

If your washroom hot water system is inadequate . . . inefficient . . . expensive to maintain . . . then see the G.E.C. without delay. However complicated the system the G.E.C. can solve your problem . . . solve it with an industrial electric water heating installation—fume-free, dust-free and thermostatically controlled to keep the water, economically, at the required temperature.

G.E.C.
INDUSTRIAL ELECTRIC
WATER HEATING

For further information, write for publication H 4.

The Company's specialist engineers are ready to give free advice and to recommend the most suitable system.

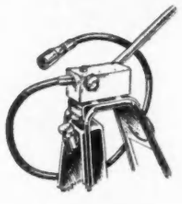
industrial storage water heaters—
for hot water in quantity to a number of points at a time.

industrial immersion heaters—
for quick and easy conversion of fuel fired systems to electric heating.

THE GENERAL ELECTRIC CO. LTD, MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

Hydra-pak

THE NEW Hydraulic HAND PUMP by TANGYE

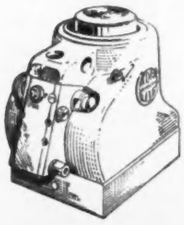


1

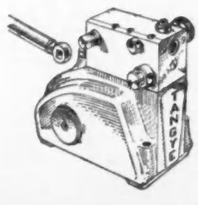
1 *The Hydra-pak on a tubular stand with oil cistern and pressure gauge.*

2 *This pump is incorporated in Tangye "Hydralite" 100 tons capacity jack.*

3 *The pump can be supplied mounted on a reservoir of 1 or 2 gals. capacity.*



2



3

This pump is a small, compact job, and will, with slight adjustments, cover a range of pressures up to 10,000 lbs. p.s.i.

It has two speeds, giving high or low pressure, and these are selected by a push-button control. Oil or water may be used.

We shall be pleased to furnish you with complete details.

Send for literature

TANGYES LIMITED
CORNWALL WORKS
SMETHWICK · BIRMINGHAM

AD. No. 48

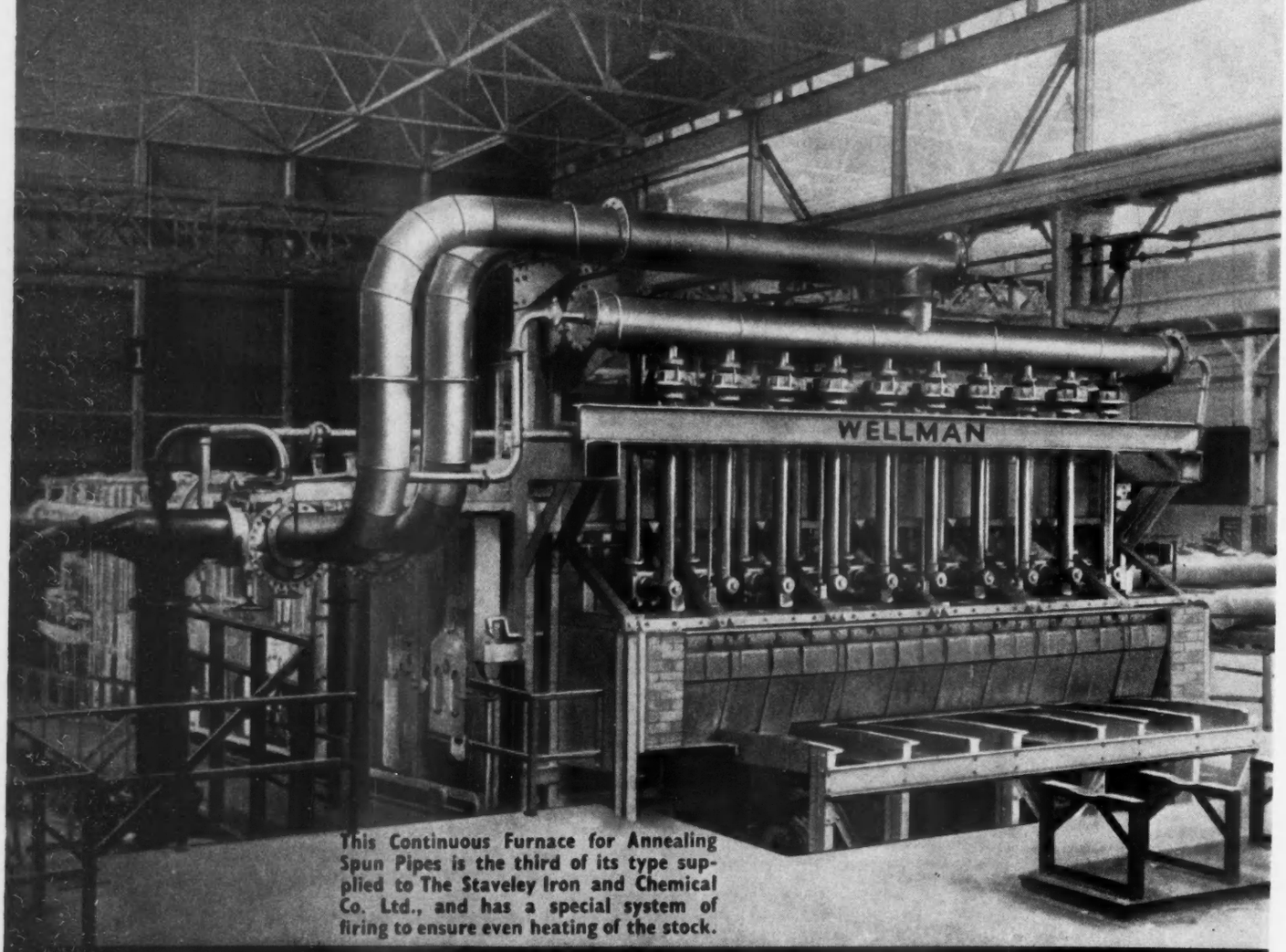
WELLMAN

Re-Heating and Heat Treatment Furnaces for the Metallurgical Industries

We design and construct Re-Heating and Heat Treatment Furnaces of many types for both ferrous and non-ferrous trades ranging from small units dealing with castings of a few pounds each up to the largest Bogie Heat Treatment Furnaces handling single pieces of 100-tons and upwards.

With the increased demands for precision and for constant quality, automatic control of furnace conditions is recognised as essential and this subject has received special attention in our engineering and research departments where every aspect of heating technology is studied.

We are also makers of the mechanical equipment required in conjunction with furnace plant, and are therefore in a unique position to design and construct complete installations incorporating the most recent advances in heat treatment and mechanical handling.

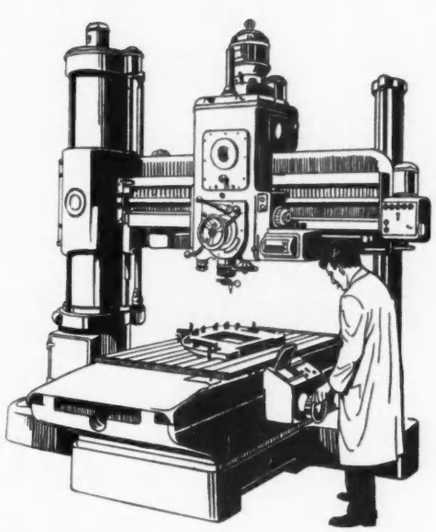


This Continuous Furnace for Annealing Spun Pipes is the third of its type supplied to The Staveley Iron and Chemical Co. Ltd., and has a special system of firing to ensure even heating of the stock.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD

PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS: DARLASTON, South Staffs, & BELFAST.

jig boring with optical accuracy



BIRMINGHAM AND BLACKBURN CONSTRUCTION CO. LTD.

The pride of our machine shop is our Optical Jig Borer, which makes possible machinery limits as fine as ± ·000125 on most types of work. We look forward to receiving your enquiries for the jigs and tools that require that little "extra" that is possible with plant of this nature.

Armoury Close, Bordesley Green, Birmingham 9 and at Harley St. Blackburn.

CORONA Ettco

BRITISH MADE

TAPPING ATTACHMENTS

Will fit any standard drilling machine with morse taper drive

Made in 3 sizes
Tapping capacity $\frac{1}{16}$" to $\frac{3}{8}$" dia.

Automatic reverse. Friction clutch drive
Tap idles in forward direction

Tap breakage practically eliminated

Telegrams 'Corona' Leicester

FREDK. POLLARD & CO. LTD.
CORONA WORKS, LEICESTER
ENGLAND

Telephone Leicester 67534 (5 lines)

What do you do with your waste oil?

WELLS FILTERS enable waste oil to be used with complete confidence many times over.

give old oil NEW LIFE

The Wells special filter pads used in conjunction with the Wells patent syphon feed make waste oil clean again.

A. C. WELLS & CO., LTD

MOUNT ST., HYDE, CHESHIRE

Tel : HYDE 2953 *GRAMS : UNBREAKABLE HYDE*

For GEARING of every description

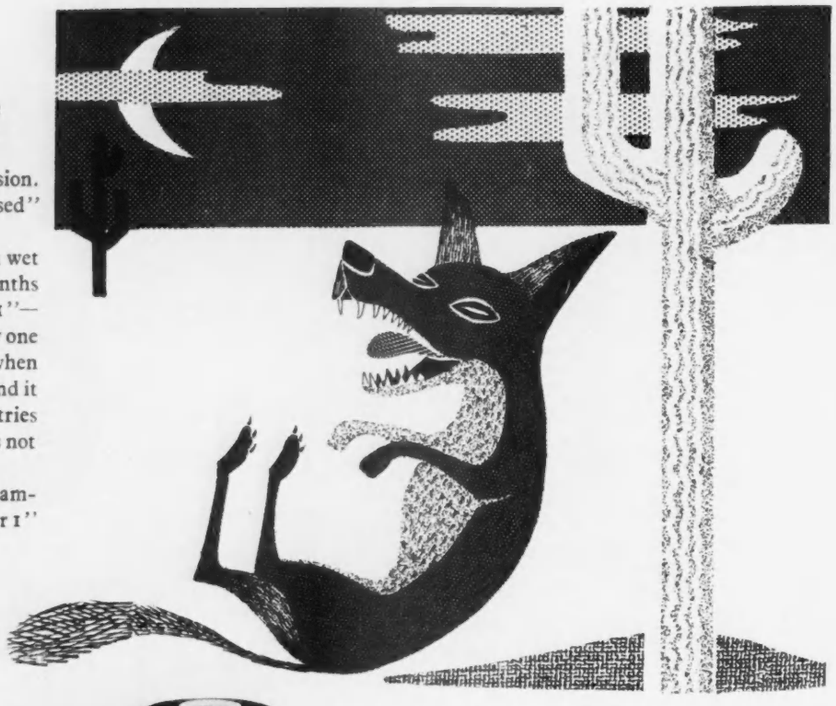
- COLLIERY GEARING A SPECIALITY
- MACHINE CUT & MACHINE MOULDED GEARS OF ALL TYPES
- PATTERN MAKERS & ENGINEERS

AURORA GEARING CO. (WILMOT NORTH) LTD.

EDMUND ROAD, SHEFFIELD 2.

Phone: SHEFFIELD 23132-3 *Grams: WHEELS, SHEFFIELD 2.*

He would try to laugh it off



But steam engineers can't afford to laugh at boiler corrosion. It can be an expensive business—unless they have "Apexiorised" at the beginning.

"Apexior Number 1" is absolute proof against corrosion in wet temperatures between 175°—1000°F. Protection for 12 months or more is assured with a double coat of "Apexior Number 1"—brush or mechanically applied. After initial treatment only one coat is necessary. Descaling problems are negligible when "Apexior Number 1" is specified because less scale forms and it is looser in formation, more easily removed. In certain industries it is a most important advantage of "Apexior" that it does not affect the water by taste, taint or smell.

These are just a few of the reasons why leading boiler and steam-raising plant manufacturers have specified "Apexior Number 1" for over 50 years.

Send for your copy of the "Apexior Manual".

DAMPNEY'S APEXIOR REGISTERED

BRITISH PAINTS LIMITED

APEXIOR DIVISION

PORTLAND ROAD, NEWCASTLE UPON TYNE, 2.

CREWE HOUSE, CURZON STREET, LONDON, W.1.

SYDNEY · ADELAIDE · TORONTO · DURBAN · CAPE TOWN
CALCUTTA · TRINIDAD · NEW YORK · ARKLOW

Our world-wide service is at your disposal for the asking

"APEXIOR NUMBER 1" PREVENTS CORROSION IN STEAM-RAISING PLANT

But for cold-wet surfaces up to 125°F.—use "APEXIOR NUMBER 3"

BPL/A.37

ELECTRIC R.P.M INDICATORS

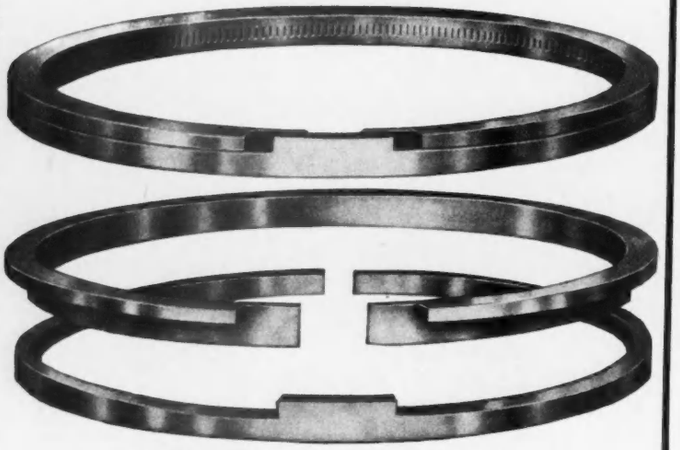
UP TO 8" DIAMETER

WYNSTRUMENTS LTD

STAVERTON AERODROME · GLOUCESTER

Phone: CHURCHDOWN 3264

STANDARD'S TRIPLE SEAL PISTON RINGS



EFFECTIVELY SEAL THREE FACES

Eliminate by-pass, Restore compression, Maintain full power, Function until bore of cylinder is worn by as much as 1%.

THE STANDARD PISTON RING & ENGINEERING CO., LTD.

PHONE: Sheffield 42076-7-8 (three lines). **DON ROAD, SHEFFIELD,** GRAMS: OCEAN SHEFFIELD.

London Office: Walter C. Jones, M.I.Mech.E., M.I.Mar.E., 57-58, Gresham House, Bishopsgate, E.C.2 (London Wall 4981)

Combined Operation by CLYDE-BOOTH

This large machine shop uses cranes designed and manufactured by our Leeds and Mossend Works. To give first class handling facilities two 30 ton E.O.T. Cranes are provided while two 4-ton Wall Cranes, positioned each side of the shop handle the smaller loads. Both types of crane embody many special features representative of our long design and manufacturing experience in this field.

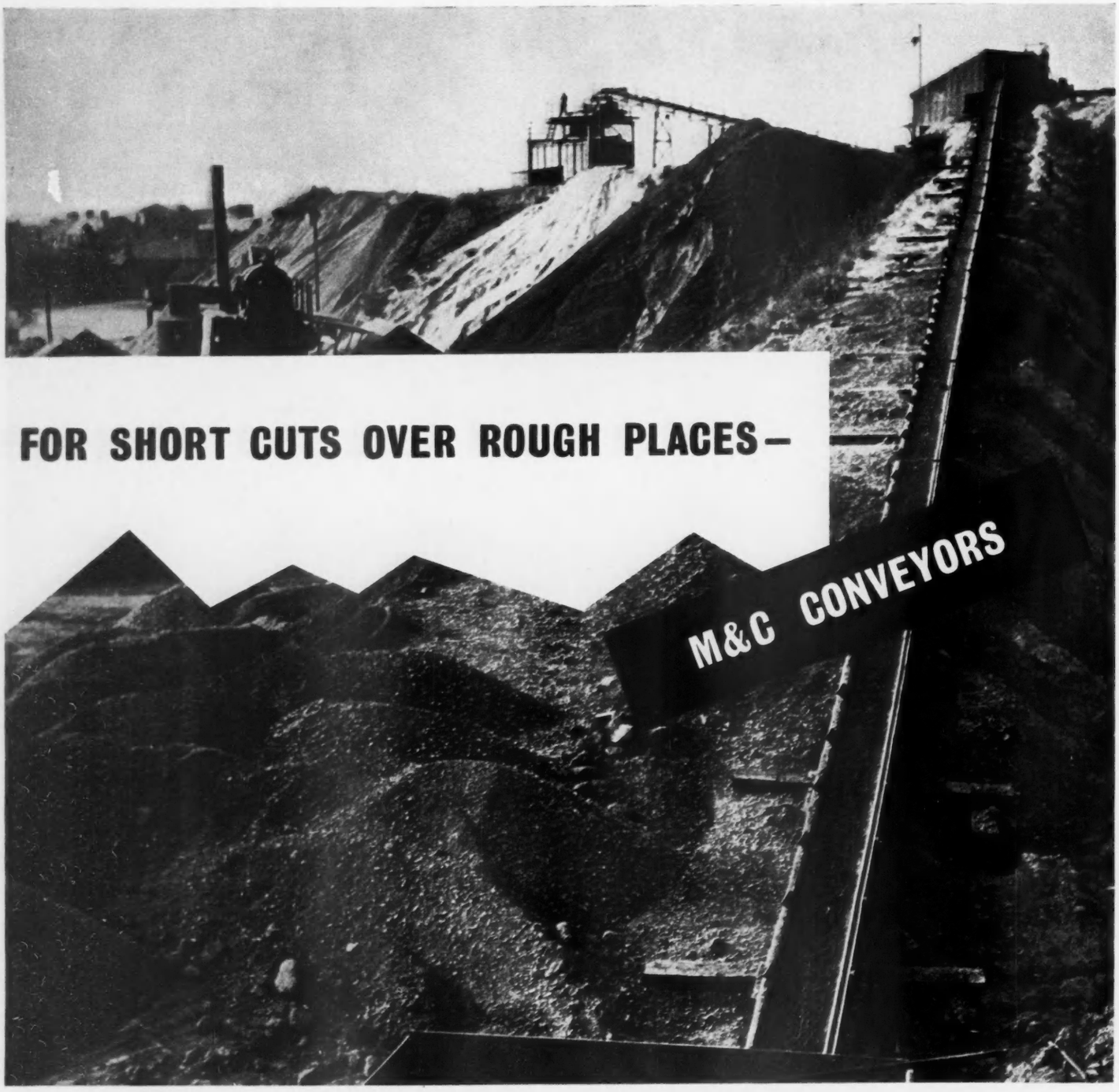
From a wide experience in designing and building all types of crane installations we should be pleased to submit proposals and designs to suit any requirements.

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD
incorporating

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire,
Telephone : Holytown 412 (6 lines). Telegrams : "Clyde," Motherwell

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds,
Telephone : Pudsey 3168 (6 lines). Telegrams : "Cranes," Rodley.



FOR SHORT CUTS OVER ROUGH PLACES—

M&C CONVEYORS

(Above) *From lorry hopper to washing plant by M&C sectional belt conveyors.*

(Left) *An M&C idler on an alternative mounting—a corrugated idler-board.*

At a large quarry in the Midlands, crushed granite had to be taken from lorries to the washing plant partly seen in the distance. Between was a waste area of tip-heaps. With little preparation of the ground, M&C sectional belt conveyors were laid over the soft piles, forming a reliable road open in all weathers. The wind blows dust and grit about but that does not worry the M&C idlers, which keep on carrying the belts with great ease and at low cost.

MAVOR & COULSON LTD

Bridgeton Glasgow S.E.
Olive Grove Road Sheffield 2
36 Victoria Street London S.W.1

Announcing the

PERRY

standard range of
HOLLOW BEARING
AND SOLID BEARING
PIN TYPE

CHAINS

AND **WHEELS**

FOR

CONVEYORS

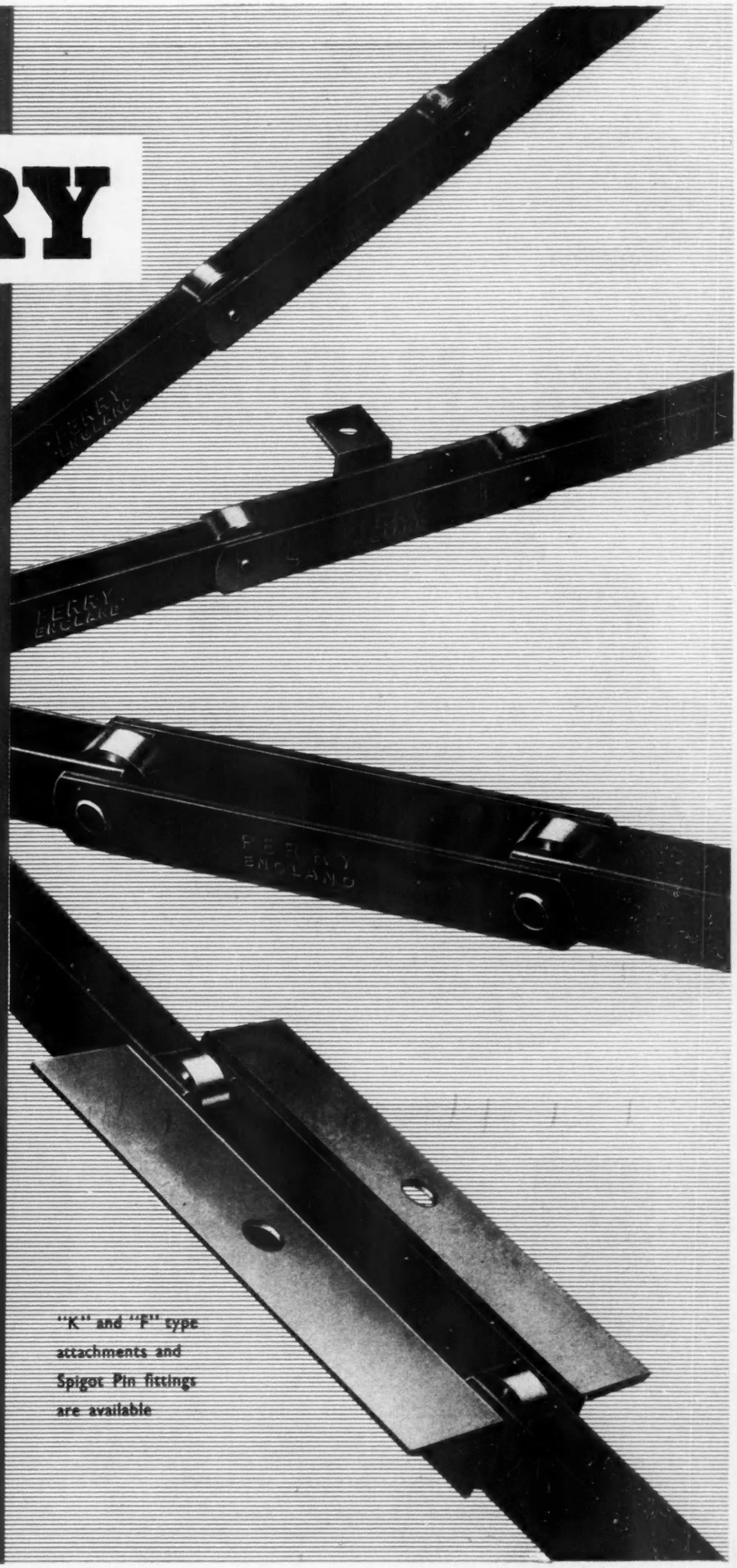
AND

ELEVATORS

UP TO 15,000 lbs.
BREAKING LOAD

Write today for free Folders illustrating and describing the new Perry standard range of Conveyor and Girder Section Chains.

PERRY CHAIN COMPANY LIMITED
TYSELEY, BIRMINGHAM 11
(A Division of the Perry Group)



"K" and "F" type attachments and Spigot Pin fittings are available

E

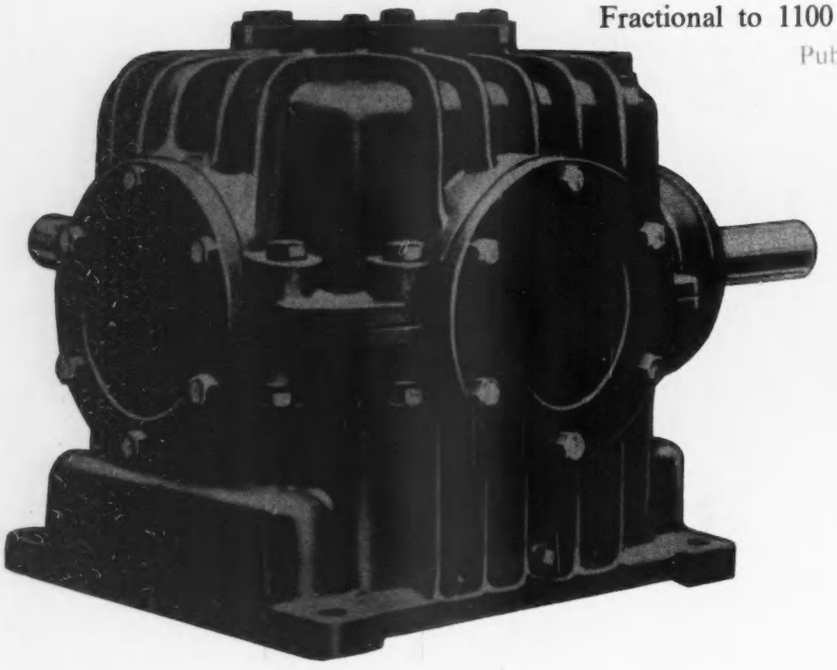
gearb

CROFTS MAKE THE
CROFTS (ENGINEERS) LIMITED

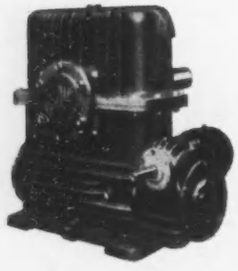
CROFTS SPIRAL BEVEL GEAR UNITS

Fractional to 1100 h.p.; ratios 1 : 1 to 5 : 1

Publication 549

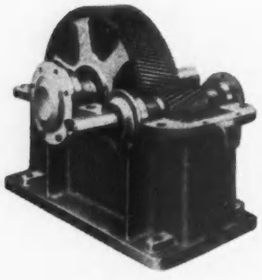


- **Vertical or horizontal designs all with any of eight shaft assembly combinations**
- **Speed reducing or increasing gears**
- **Ideal for heavy-duty right-angled drives**



Combined Double Reduction Worm Gears

Publication 524



Single Helical Gear Units

Send us your enquiries

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

Head Office: Thornbury, Bradford 3, Yorkshire

Telephone: 65251 (20 lines) Telegrams: "Crofters Bradford Telex" Telex 51186

Branches at:

Belfast, Birmingham, Bristol, Cardiff, Dublin, Glasgow, Leeds, Liverpool, London, Manchester, Newcastle, Northampton, Nottingham, Sheffield, Stoke-on-Trent.

REPRESENTED THROUGHOUT THE WORLD.

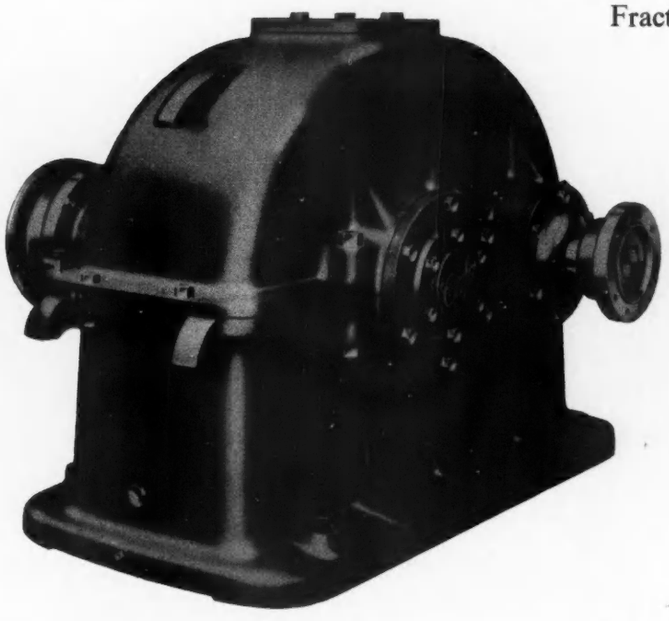
oxes

FINEST YOU CAN BUY
POWER TRANSMISSION ENGINEERS

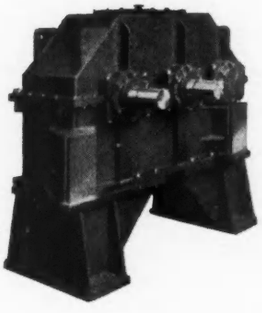
CROFTS DOUBLE HELICAL GEAR UNITS

Fractional to 3250 h.p.; ratios up to 50 : 1

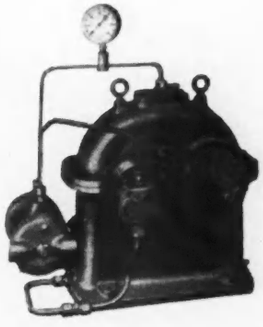
Publication 535



- **A high quality heavy duty reduction gear**
- **Standard and high ratio single reduction units; double reduction units also with coaxial input and output shafts**
- **Special units for larger powers or with special gear combinations made to order**



Special Fabricated Gear Units
All types for every duty



Medium Power Turbine Gears
Publication 5327

Makers of:

Clutches, Conveyor drives, Couplings of all types, Double helical gear units, Fabricated steelwork, Geared motors, Hydraulic couplings, Iron, steel and non-ferrous castings, Machine-cut gears of all types, Motorised rollers, Patent taper-flushbushes, Plummer blocks, Shaft-mounted gear units, Special machinery drives, Spiral bevel gear units, Turbine gears, V-rope Drives, Variable speed drives, Worm reduction gears.

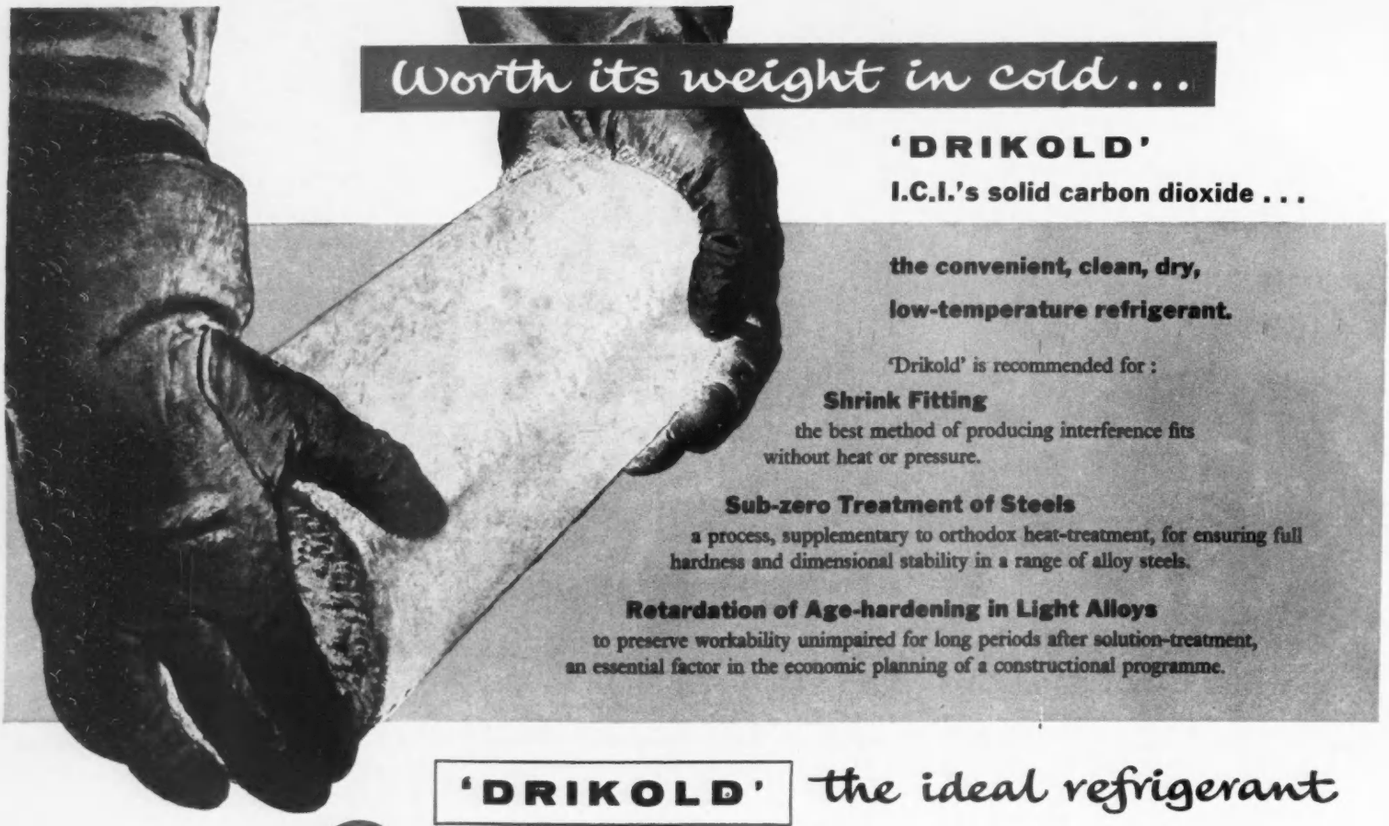
CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

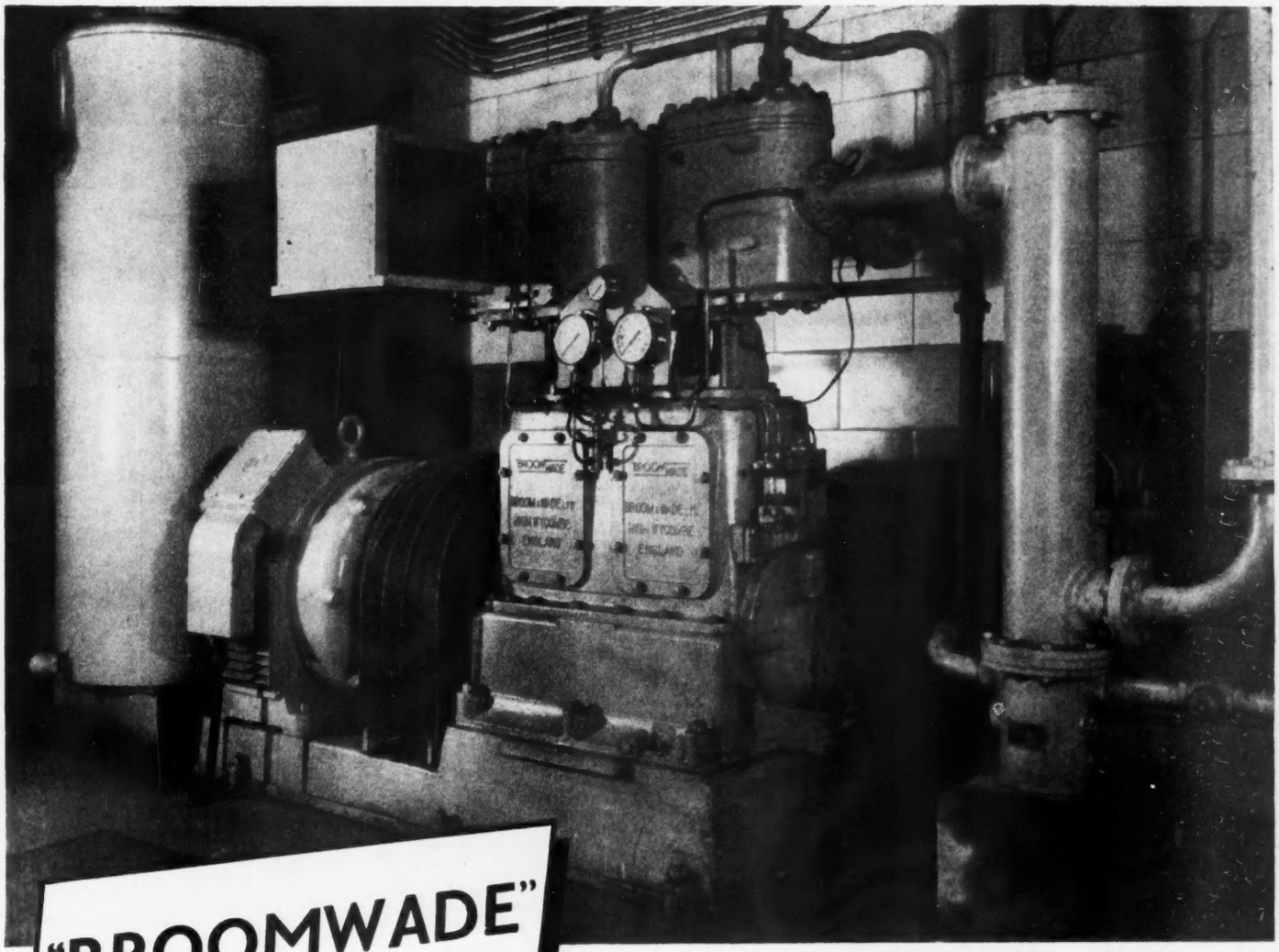
Head Office: Thornbury, Bradford 3, Yorkshire

Telephone: 65251 (20 lines) Telegrams: "Crofters Bradford Telex" Telex 51186

MARS-LUMOGRAPH
DRAWING AND BLUE-PRINT PENCILS
are specially produced to meet the needs of architects, draughtsmen and others who require pencils of the highest quality.
They give a clear black line, not easily smudged, and are specially treated with a patent substance that gives perfect blue-prints.
2886 MARS-LUMOGRAPH, cedar wood pencils available in 19 different degrees.
1001 MARS-LUMOGRAPH-TECHNICO, the modern clutch pencil, in 15 degrees specially balanced and designed to give a perfect grip.
Obtainable from all high-class Stationers and Drawing Office Suppliers, Trade enquiries to:
J. S. STAEDTLER, Ltd.,
83 Copers Cope Road,
Beckenham, Kent.
STAEDTLER PENCILS MADE IN BAVARIA SINCE 1661
HB 2886 J.S.STAEDTLER MARS-LUMOGRAPH
H 1001 J.S.STAEDTLER MARS-LUMOGRAPH <TECHNICO>
STAEDTLER-MARS


Worth its weight in cold...
'DRIKOLD'
I.C.I.'s solid carbon dioxide . . .
the convenient, clean, dry,
low-temperature refrigerant.
'Drikold' is recommended for :
Shrink Fitting
the best method of producing interference fits without heat or pressure.
Sub-zero Treatment of Steels
a process, supplementary to orthodox heat-treatment, for ensuring full hardness and dimensional stability in a range of alloy steels.
Retardation of Age-hardening in Light Alloys
to preserve workability unimpaired for long periods after solution-treatment, an essential factor in the economic planning of a constructional programme.
'DRIKOLD' the ideal refrigerant
ICI
Full information from:
Imperial Chemical Industries Limited · London · S.W.1

DE.256



"BROOMWADE"

Photograph by courtesy of Central Electricity Authority (Eastern Division)

. . . IN THE POWER STATION

This "BROOMWADE" TS1A stationary air compressor is used for maintenance purposes at the Rye House Generating Station, near Hoddesdon.

Simple design, slow speeds and adequate cooling ensure high efficiency. Constant research and development maintain the "BROOMWADE" reputation for RELIABILITY.

All over Britain, "BROOMWADE" is playing a vital part in constructing, operating and maintaining modern power stations to meet industry's ever-increasing demand for electricity.

The "BROOMWADE" organisation, backed by sixty years' engineering experience of the highest order, is equipped to offer sound technical advice on any problem involving the use of compressed air.

A first-class after-sales service is available throughout the world.

"BROOMWADE"

Air Compressors and Pneumatic Tools

Your Best Investment

BROOM & WADE LTD., P.O. BOX NO. 7, HIGH WYCOMBE, ENGLAND. *Telephone: High Wycombe 1630 (10 lines). Telegrams: "Broom," High Wycombe, Telex.*

302 SAS

F

What has the Cutty Sark to do with INSULATION?

The Cutty Sark is berthed within sight of the wharves of the Greenwich Insulation Company Ltd, whose skilled tradesmen throughout Britain specialise in the application of Thermal Insulation to chemical, oil, engineering, and all types of industrial plant. Like the Cutty Sark, the work of the Greenwich Insulation Company Ltd bears the stamp of craftsmanship and durability.

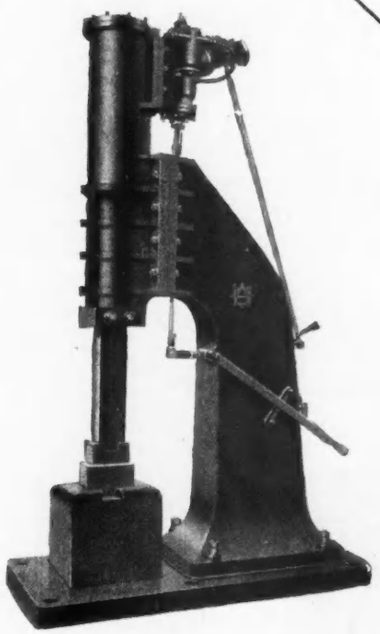
GREENWICH INSULATION COMPANY LIMITED

ONE OF THE RBH GROUP

HARTS WHARF, NORMAN ROAD
GREENWICH, LONDON S.E.10
Telephone: GREenwich 4851/2/3

The Hall Mark tells a story . . .

For 650 years these marks have provided a unique guarantee of maker, quality, origin and date. Shown below are those which would appear on an article made by Zedd and Co. Ltd., from Britannia Silver (indicated by the figure of Britannia) made in Birmingham (the Anchor) in 1950 (the letter 'A' drawn a particular way).



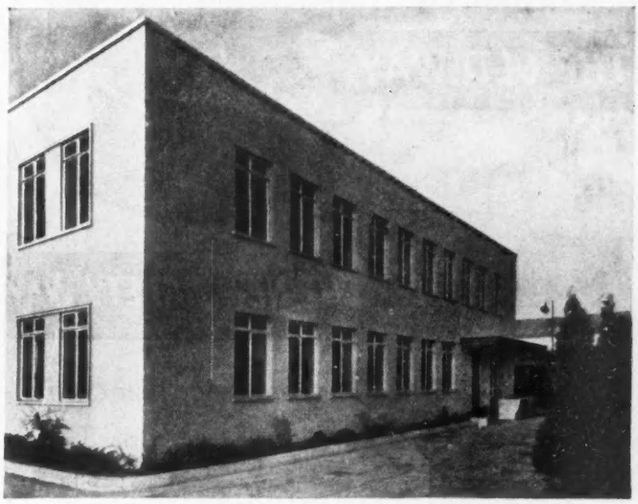
This mark is also an accepted world standard of quality in engineering; foremost in design and efficiency. From the wide range of Alldays and Onions products we show you here the N.S.K. HAMMER.

ALLDAYS & ONIONS LTD.

GREAT WESTERN WORKS
BIRMINGHAM, 11.
'Phone: VICtoria 2251-4

London Office: 2 Queen Anne's Gate, Westminster, S.W.1. 'Phone: WHitehall 1923/4/5

Streamlined SERVICE



BECAUSE we have equipped and staffed our organisation technically and specifically to deal with ***all*** *the problems of modern metal cleaning, we are able to provide the right process and the right product to meet any unusual requirement. Consultation with "S.A.C." technicians is the streamlined way of getting the answer which saves you time and cost.*

PRODUCTION PROVED PRODUCTS

SUNBEAM ANTI-CORROSIVES LTD.

CENTRAL WORKS · CENTRAL AVENUE
WEST MOLESEY · SURREY

Telephone: Molesey 4484 (5 lines)
Telegrams: Sunanticor, East Molesey

Manufacturers of
STRIPALENE · FERROCLENE · ALOCLENE · FERROMEDE · BRAZOCLENE
(Regd. Trade Marks)

APPROVED BY ADMIRALTY, WAR OFFICE AND AIR MINISTRY

AIRNESCO PRODUCTS LTD.

· STROOD · ROCHESTER · KENT · ENGLAND ·

This winter's **BUNKER TRIMMING**

THE OLD WAY

THE NEW SAFETY WAY

Percussion Lancing...

✳ Keeps men out of the Bunkers

✳ Clears stoppages faster

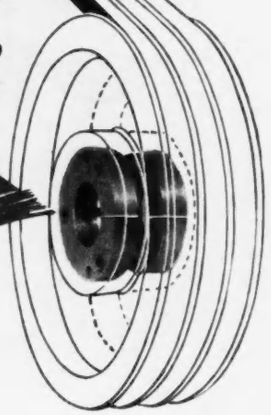
✳ Costs Less

May we demonstrate at Your works? TELEPHONE STROOD 78310

Dualok

The PATENTED *Taper Grip V-Pulley*

100 H.P. GUARANTEED WITHOUT A KEYWAY



1 Only DUALOK has the patent TWIN Bush for *DOUBLE - GRIP*. Simple, safe, easy to fit.

2 Only DUALOK is made and **guaranteed** without a Keyway.

3 DUALOK is the ONLY "Taper-Grip" that does not need time-wasting and expensive Keyways on the HEAVIER Drives.

Write now for full details and name of nearest stockist.

Immediate delivery from Stock up to 100 H.P.

● DUALOK—the British hub for V-Belt Pulleys, Flat Belt Pulleys, Chain Sprockets, Fan Centres, etc.

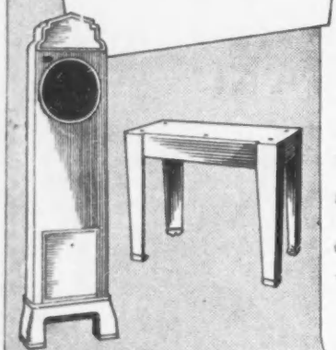
THE ZERNY ENGINEERING CO. LTD., RICKMANSWORTH, HERTS.

Phone: Rickmansworth 4777/8

Sheet Metal Workers of Repute

Established 1857

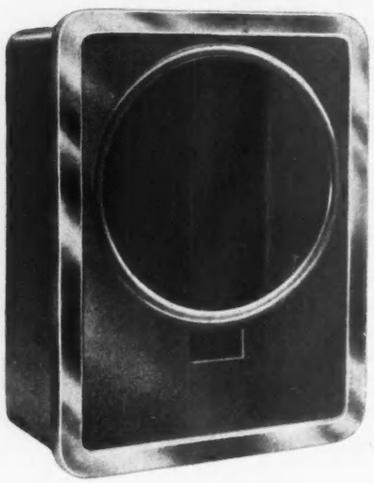
We have modern plant and 100 years Experience which enables us to carry out a great variety of work and meet all needs.

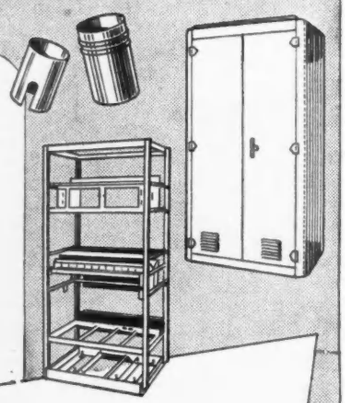


The meter case illustrated is an example of where customers' requirements are best met by a combination of press work and fabrication. Both door and case are manufactured from Mild Steel Sheet; the former being a 16G pressing, and the latter a 14G fabrication.

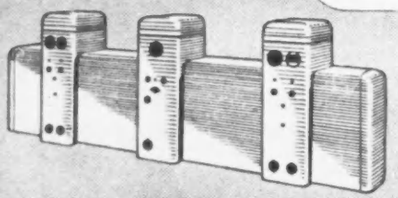
•

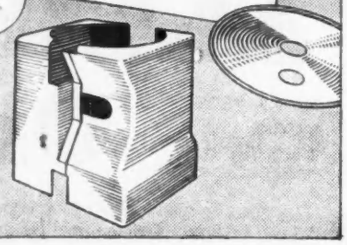
Contractors to Admiralty, Ministry of Supply and G.P.O.





Well-equipped tool-room for the manufacture of the necessary tools to your designs or our own.





J. RICHARDS & SONS LTD.

31 - 37 WELLESLEY ROAD · CROYDON · SURREY

Telephone: CROYDON 2128/9

Overhead Cranes

Lifting up to 75 TONS

Spans up to – 100 feet

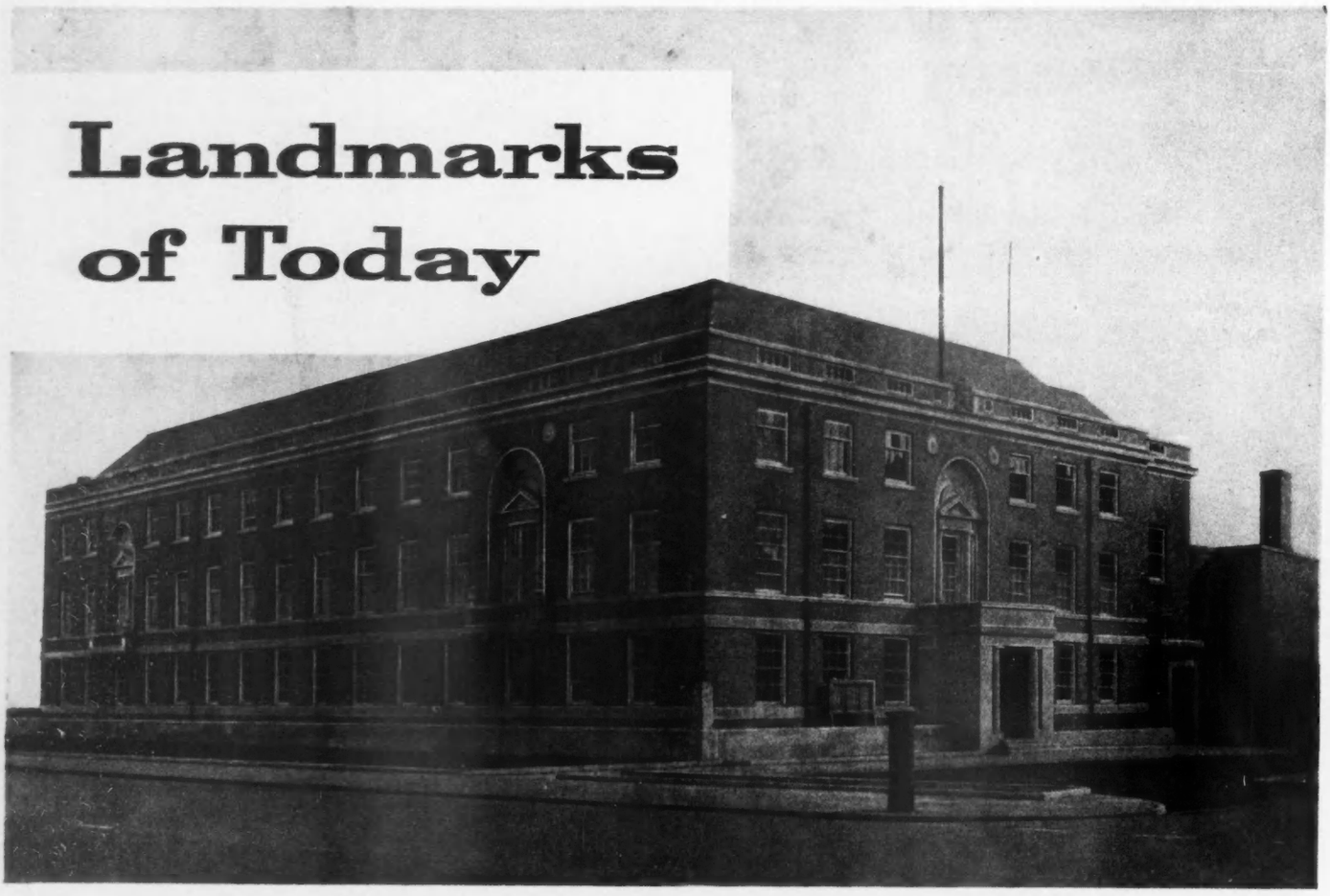
John Smith CRANES

JOHN SMITH (KEIGHLEY) LTD.

P.O. Box 21, The Crane Works, Keighley, Yorks. Tel : Keighley 2283/4

London Office : *Buckingham House, 19-21 Palace St., Westminster, London S.W.1.*
Southern Counties Office : *Brettenham House, Lancaster Place, London W.C.2.*

Landmarks of Today

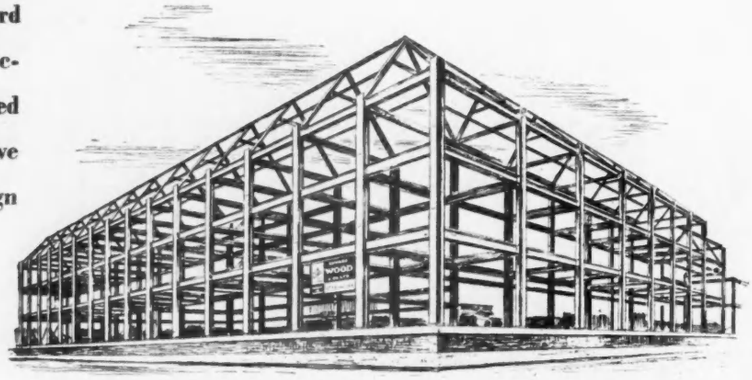


Architects and Surveyors, Bradshaw Gass & Hope, FF.R.I.B.A.

EDWARD WOOD & CO LTD

CONSTRUCTIONAL ENGINEERS

The new Headquarters building for the Salford City Police is a fine example of modern construction. The strength of the force can be compared with the solidity of this building for which we fabricated and erected the steelwork to the design of Bradshaw Gass & Hope, FF.R.I.B.A.



Registered Office and Works: *Telephone : TRAfford Park 2341 (10 lines)*

OCEAN IRONWORKS · TRAFFORD PARK · MANCHESTER 17

London Office : 68 Victoria Street, S.W.1. Telephone : VICtoria 1331/2 · *Technical Offices at Birmingham and Nottingham*

dm WD 73

SHEET METAL WORK & ENGINEERING FOR *EVERY INDUSTRY

For many years we have enjoyed a reputation for work o the highest quality and precision finish. Our spacious workshops house some of the most up-to-date metal working machinery and our resources are available to those who require prototypes or pilot runs as well as to those whose demand is for quantity production.

*** AUTOMOBILE**
Body panels, wings, cabs, silencers, petrol tanks, etc., etc.

*** ELECTRONICS**
Main control cabinets, instrument panels and boxes, receiver chassis, etc.

*** AIRCRAFT**
Fuel tanks, elevators, tail planes, pressings, fabrications in all metals.

Our Sheet Metal Working Plant includes:
Presses up to 200 tons, Guillotines, Wiring Machines, Press Brakes, Benders, Riveting and all types of Welding and General Engineering Plant.

E.G. Brown & Co. Ltd

WEST ROAD, TOTTENHAM,
LONDON, N.17
Telephone: TOTtenham 2257-8-9

An Unusual Transformer Repair

This is a 'what-is-it' picture taken recently in one of our works. It is a 500 K.V.A. 200 cycle single turn secondary transformer for tube welding and is water cooled. It was completely rewound by us with Class H insulation.
The ability to tackle the unusual can indicate that the commonplace is done exceptionally well. That is true of each of the 14 B.E.R.L. Works — at your service night and day.

B.E.R.L.

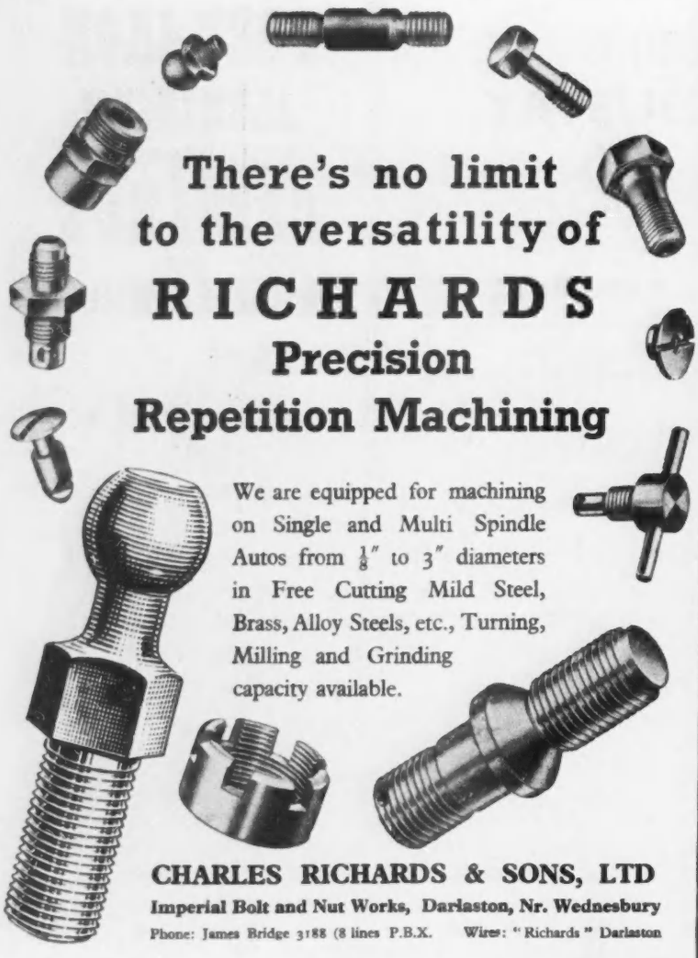
BRITISH ELECTRICAL REPAIRS LTD
Empire House, Charlotte St., Manchester 1
Works at:
BATH, BIRMINGHAM, CARDIFF, CHESTERFIELD, EDINBURGH, GLASGOW, HAWICK, LONDON, MANCHESTER, NEWCASTLE, SWANSEA

dm BER.64

GREY IRON
ALUMINIUM
NON-FERROUS
CASTINGS
AND
MACHINED ASSEMBLIES

also
DIE CASTINGS
IN ALUMINIUM
MAZAK, LEAD
& TIN ALLOYS

ECLIPSE FOUNDRY & ENGINEERING CO. (DUDLEY) LTD.
BRITANNIA WORKS,
SEDGLEY ROAD, WEST
TIPTON, STAFFS.
Telephone: TIPton 2545 (3 lines)



There's no limit to the versatility of RICHARDS Precision Repetition Machining

We are equipped for machining on Single and Multi Spindle Autos from $\frac{1}{8}$" to 3" diameters in Free Cutting Mild Steel, Brass, Alloy Steels, etc., Turning, Milling and Grinding capacity available.

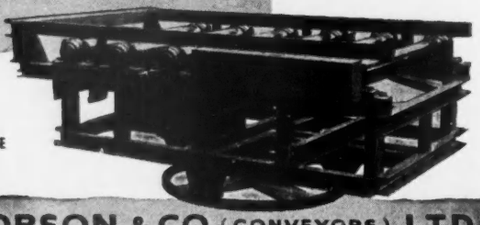
CHARLES RICHARDS & SONS, LTD
Imperial Bolt and Nut Works, Darlaston, Nr. Wednesbury
Phone: James Bridge 3188 (8 lines P.B.X. Wires: "Richards" Darlaston

FOR MANY PRACTICAL PURPOSES
engineers use
"Plasticine"
Reg'd Trade Mark

'Plasticine' has many important uses in engineering. Uses as wide apart as making experimental models and retrieving small parts which have fallen into a machine. 'Plasticine' is ductile, antiseptic, watertight, stable in character, and it adheres quite easily to metal. It is ideal for sealing and for holding irregular objects in position. Every engineer should have 'Plasticine' at hand. For more detailed information on its uses write to:—

HARBUTT'S PLASTICINE LTD. (Dept. E), BATHAMPTON, BATH, SOMERSET
Harbutt's were the inventors and remain the sole makers of 'Plasticine'

ROBSON CONVEYORS
ESTABLISHED 1906

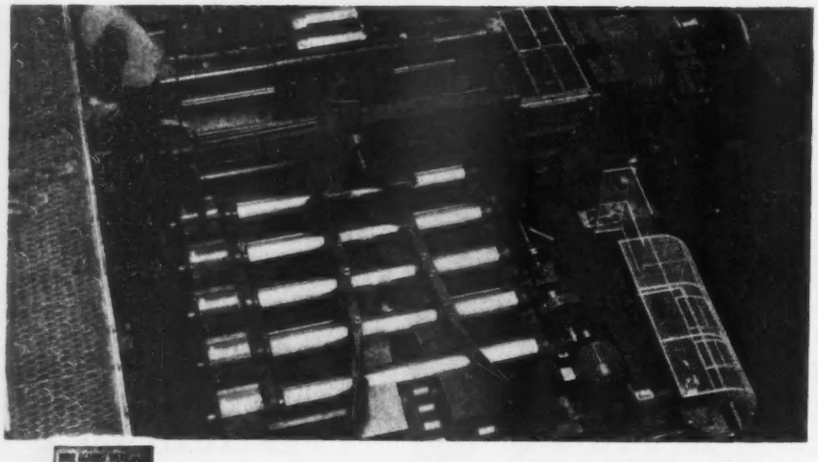


10 TON ROLLER TURNTABLE

Geo. ROBSON & CO. (CONVEYORS) LTD.
HODGSON STREET · SHEFFIELD.
PHONE. SHEFFIELD 27463/4

ARMOURCHROME

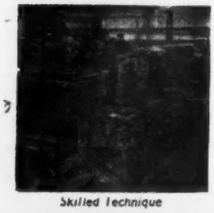
The PROVEN process for Hard Chromium Deposition



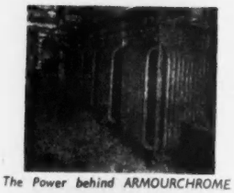
Armourchromed Rolls, over 11ft long, in use at Banbury.
Photograph by courtesy of The Northern Aluminium Co. Ltd.

ARMOURCHROME will increase the working life of Rolls, Die-Sets and Press Tools several times. Be sure your NEW equipment is pre-treated with this cost-cutting, ultra-durable process and remember that worn, rejected components can be reclaimed by the application of ARMOURCHROME. Approved by A.I.D. Test House and the various Ministries, ARMOURCHROME provides a VDH rating of approximately 900, helps to eliminate scoring, roll marks and other blemishes from the finished job besides giving protection from deterioration in storage. Ask our Technical Sales Department for further details NOW !

Scientific Control



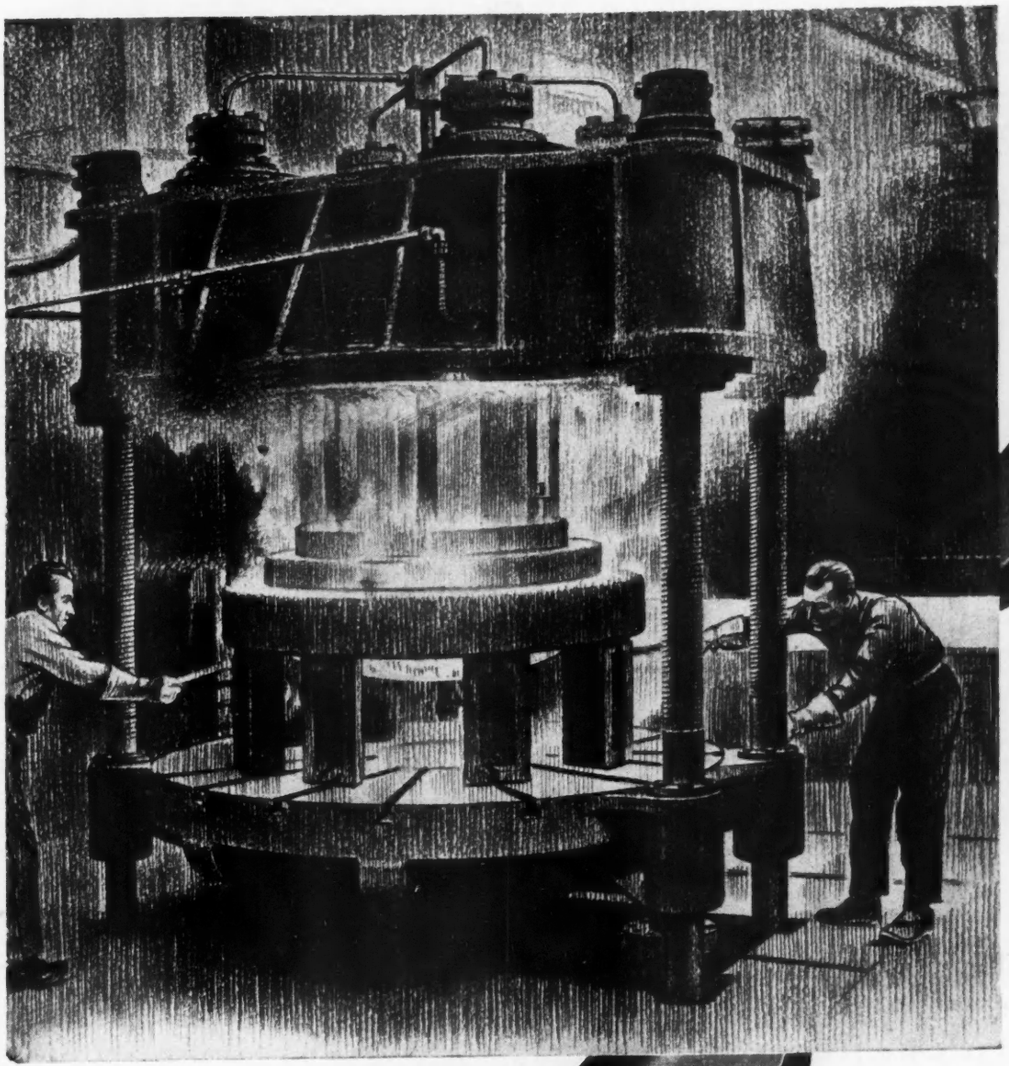
Skilled Technique



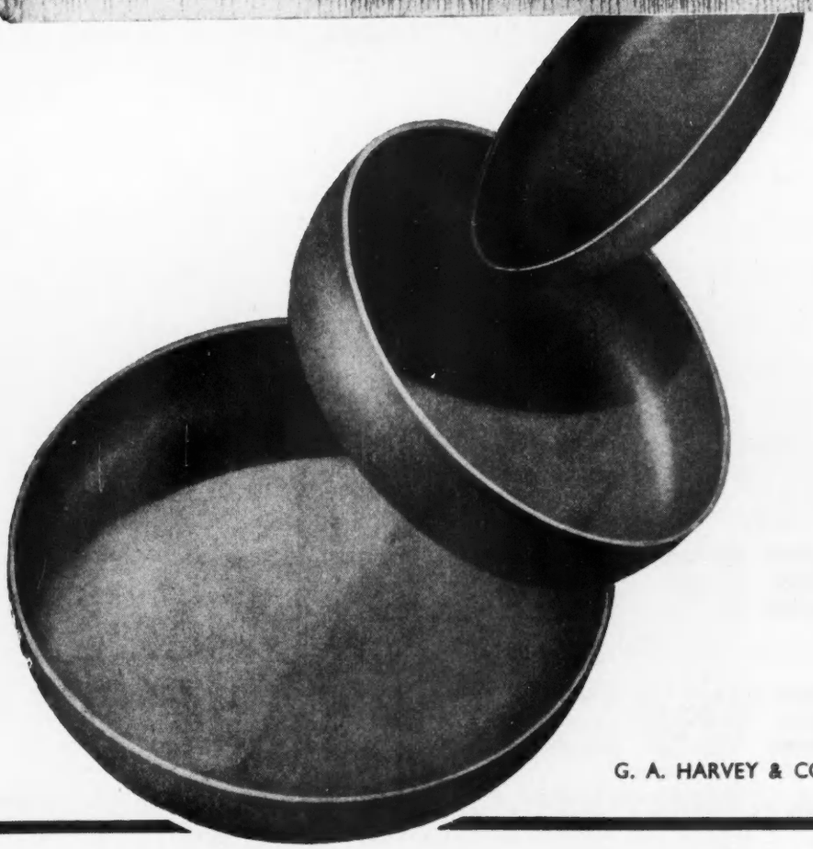
The Power behind ARMOURCHROME

Precision Inspection

THE BRIGHTSIDE PLATING COMPANY LTD.,
Brearley Street · Birmingham 19 · Tel: Aston Cross 2663



DISHED and FLANGED ENDS



Fabrication of pressure vessels may be greatly facilitated by drawing upon Harvey resources for the production of die-pressed Dished and Flanged Ends.

Capacities range from 6 ins. to 9 ft. diameter. Edges are prepared for welding or riveting if desired.

STOCK SIZES: Ends pressed from Boiler Quality or Ship Quality Mild Steel up to $\frac{1}{2}$ in. thickness, in most sizes up to 7 ft. diameter, are normally available from stock.

SEMI-ELLIPSOIDAL HEADS can be produced on the Rotarpress; diameters 5 ft. to 15 ft.; thicknesses $\frac{3}{8}$ in. to 4 ins. For details, please ask for List No. E965.

Harvey

G. A. HARVEY & CO. (LONDON) LTD., WOOLWICH ROAD, LONDON, S.E.7
Telephone: GREenwich 3232 (22 lines)

Opperman Gears go a long way . . .

. . . even as far as New Zealand, where this 22′ 6″ bedplate assembly is to be installed. They go a long way too, towards covering every industrial requirement from ¼ H.P. to 120 H.P.

We are always prepared to offer our services and advice on gearing problems, based on our long trade experience—and to produce gears to customers' special requirements. We manufacture a complete range of Spur, Helical and Worm gear reduction units to meet every normal application. Our comprehensive catalogue, containing details, dimensions, ratings and outline drawings is available on application.

The above illustration shows a type SV.12, single reduction worm gear box, ratio 10.833:1, with pump feed lubrication to top bearings, transmitting an input of 50 H.P. at 1460 r.p.m., from a totally enclosed English Electric motor, through a "Silentbloc" coupling drive on a continuous twenty-four-hours-per-day duty.

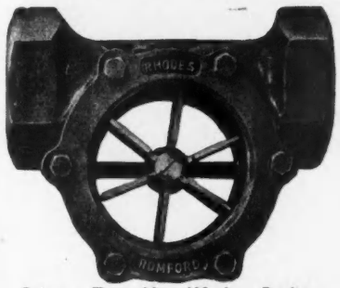
The equipment was supplied to the order of Film Cooling Towers (1925) Limited for W. J. Fraser & Co. Limited, and is for installation on an induced draught cooling tower erected in New Zealand.

OPPERMANS of NEWBURY

OPPERMAN GEARS LTD., NEWBURY, BERKSHIRE · Telephone: Newbury 1701 · Telegrams: Oppigears, Newbury

RHODES SIGHT FLOW INDICATORS

For Chemicals, Oils and cooling water



Spinner Type No. 408 for Cooling Water or oil circuits, vertical, upward or downward and horizontal flow.

are made in
BRONZE CAST IRON
MONEL INCONEL
PURE NICKEL
STAINLESS STEEL
ANTIMONIAL LEAD
NICKEL MOLYBDENUM

ALL TYPES AVAILABLE WITH SCREWED OR FLANGED ENDS

May we have your enquiries:—

B. RHODES & SON LTD.
QUEEN STREET, ROMFORD, ESSEX
Telephone: ROMFORD 62333 & 62334

CASTINGS

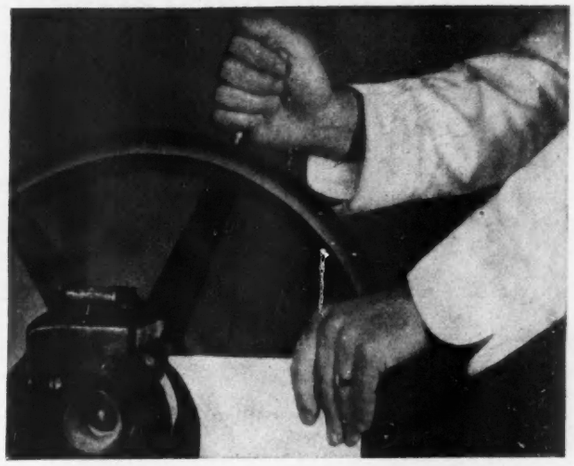
HIGH QUALITY ENGINEERING & MACHINE TOOL CASTINGS

HEAT & WEAR RESISTING UP TO 10 TONS also in SPHEROIDAL GRAPHITE IRON & STEEL

MACHINING

R. GOODWIN & SONS (ENGINEERS) LTD.
IVY HOUSE FOUNDRY, HANLEY, STOKE-ON-TRENT Phone: Stoke-on-Trent 23612

Are these hands helping you?



Chemists on our staff make sure that the P.J. finishing paints you use are ahead of competition, Pinchin Johnson maintain a separate laboratory where customers' requirements are studied and formulations evolved to meet them. Your P.J. Representative, himself a trained technician, is the link that makes the country's most advanced paint research centre an effective annexe to your factory.

You can rely on

PINCHIN JOHNSON

for Paint and Service

PINCHIN, JOHNSON & CO., 4 CARLTON GARDENS, S.W.1
Telephone: TRAfalgar 5600
BELFAST · BIRMINGHAM · BOOTLE · BRIGHTON · BRISTOL · GLASGOW
LEEDS · MANCHESTER · NEWCASTLE-ON-TYNE · SOUTHAMPTON

Specialists in the manufacture of extruded round, square and hexagon Brass Rods, in machining, hot stamping, high tensile and Naval Brasses. We manufacture to a wide range of specifications, including Overseas Specifications. Delivery throughout the country by our own transport.

Brass RODS

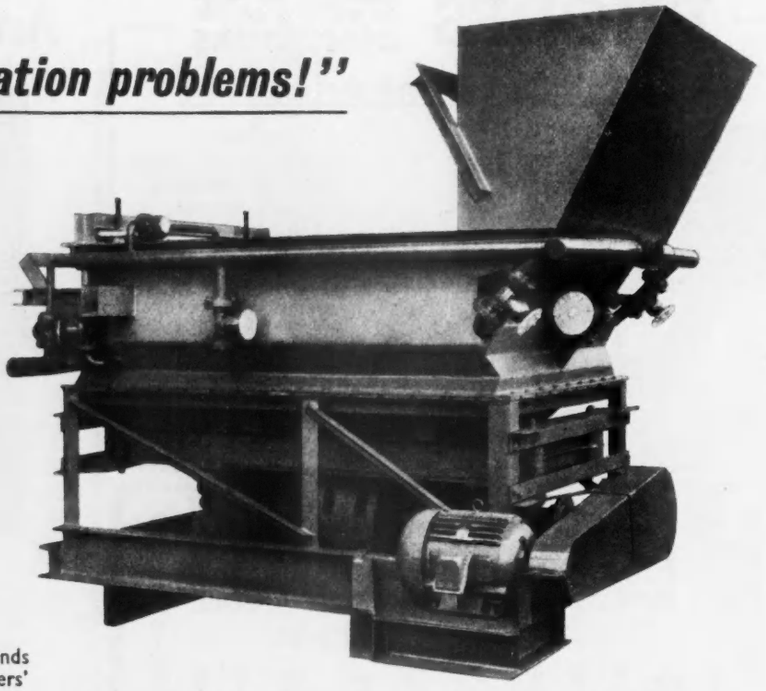
HOLMAN MICHELL & CO., LTD.

Full particulars and illustrated Brochure forwarded on request

Head Office & Works:—
CORNWALL WORKS, ST. HELENS, LANCS.
Tel.: ST. HELENS 4201-2-3-4.
Branch Works & N.E. Area Sales Office:—
WAKEFIELD, YORKS.
Also at:—BIRMINGHAM & GLASGOW.

"Spencers solve our fabrication problems!"

The wide experience of Spencers' engineers meets the demands of modern industry for accurate interpretation of designers' work and in solving many production problems.



This Floatex Meckum Jig for instance, which removes through stratification by water pulsation, impurities in sand and gravel ; was built for Floatex Separations Ltd, of Broadway, Worcs. It is typical of the scope of individual precision metal fabrication which Spencers undertake for all branches of the Engineering Industries and Electronic Industries, etc. The range of productions includes Fabrication for Control Panels, Cabinets, Tanks, Hoppers, Chimneys etc and assemblies in mild or stainless steels and other metals, either rivetted, bolted or welded construction.

SPENCER & SONS
(MARKET HARBOROUGH) LTD.

Fabrications in Steel and light Alloys

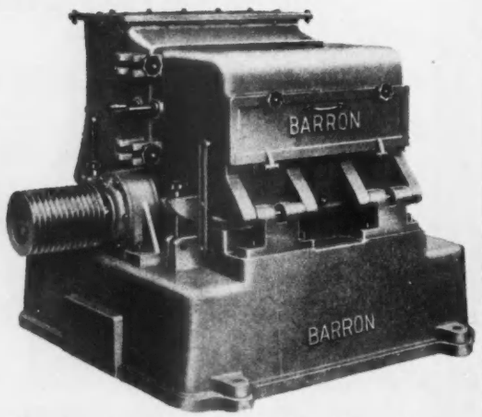
We welcome your enquiries and our advice on any metal fabrication problem is yours for the asking.

SPENCER & SONS (Market Harborough) LTD. · GREAT BOWDEN ROAD · MARKET HARBOROUGH · TELEPHONE 2651/2

For the reduction of all types of materials

THE **ROTARY PULVERISER**

A mill substantially built for continuous operation and capable of handling such varied materials as limestone, chemicals, cereals, wood, bones, roots, etc. Our latest type Rotary Pulveriser illustrated is described fully in our leaflet No. 103, a copy of which will be gladly sent on request.



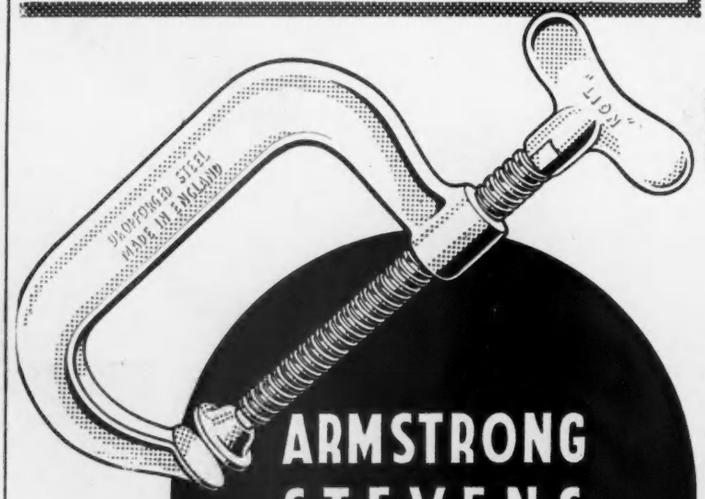
Can we assist you in your grinding problem. We manufacture many different types of mills in addition to the above machine, including Impact Grinders, Disc or Plate Mills, Stone Mills, Roller Mills and your specific requirements can no doubt be met by one or other of these machines.

W. S. BARRON & SON LTD.

GLOUCESTER

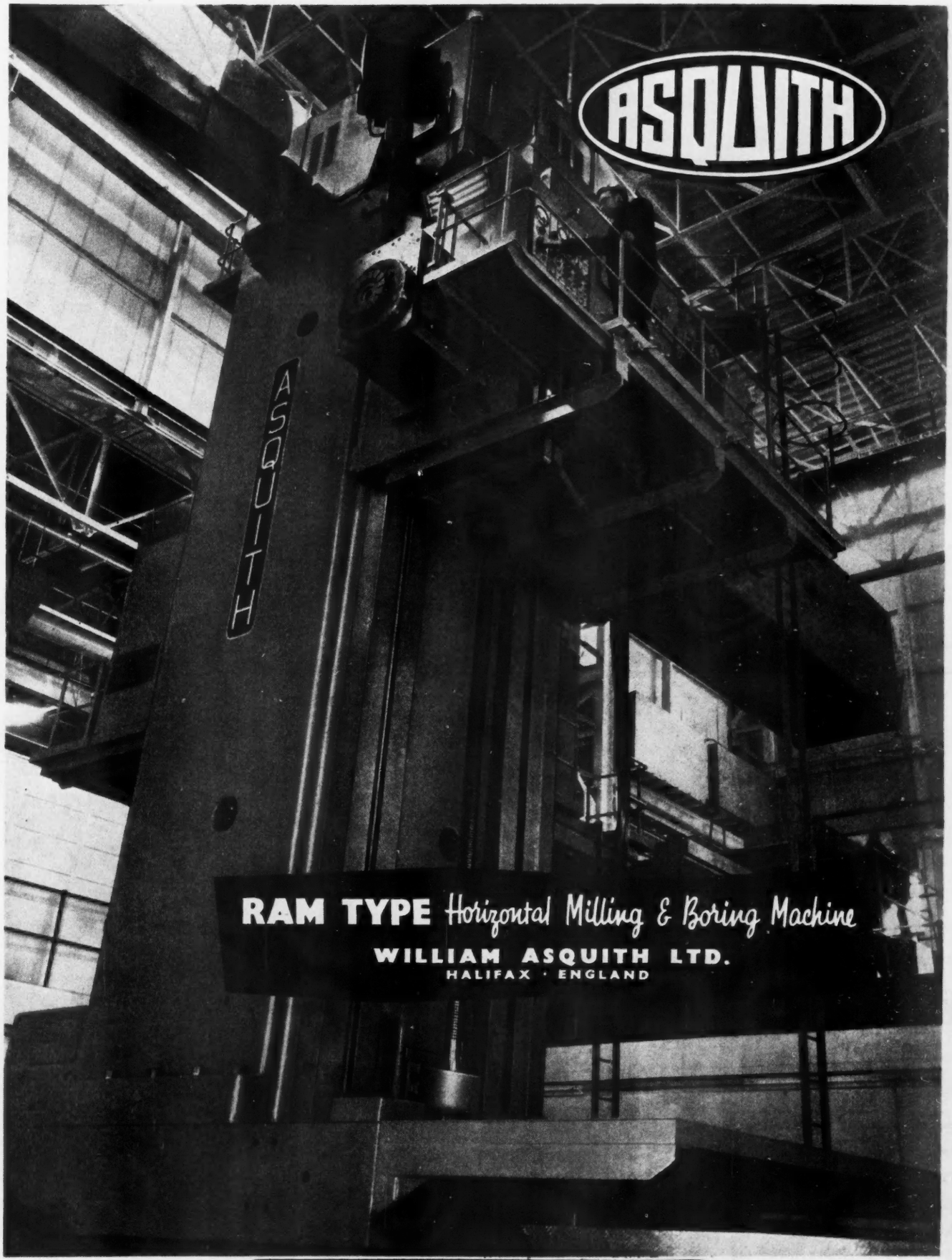
Phone : 21055/6/7 Gloucester Cable : Barron, Gloucester

LION BRAND DROP FORGED "C" CLAMPS



ARMSTRONG STEVENS AND SON LTD.
WILLENHALL STAFFS.

REGISTERED TRADE MARK

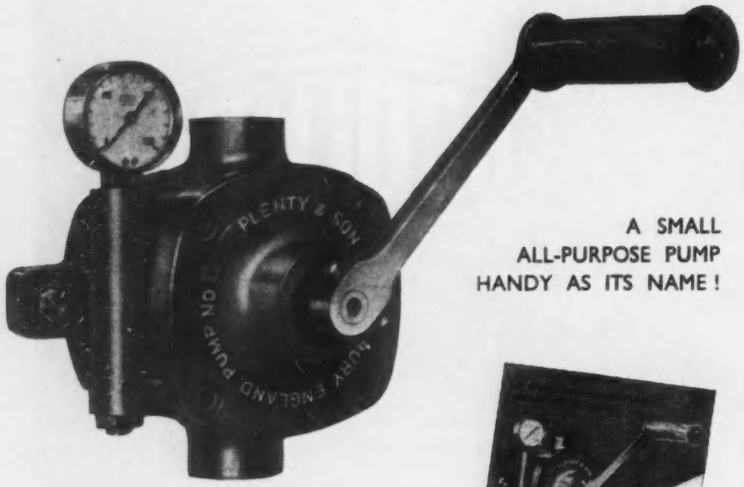


Sales & Service for . . . **DRUMMOND-ASQUITH** . . . the British Isles

DRUMMOND-ASQUITH (SALES) LTD., KING EDWARD HOUSE, NEW ST., BIRMINGHAM

'Phone : Midland 3431 (7 lines) 'Grams : Maxishape, B'ham. Also at LONDON : Phone : Trafalgar 7224 (5 lines) and GLASGOW : 'Phone : Central 3418

S233



A SMALL
ALL-PURPOSE PUMP
HANDY AS ITS NAME!

Use the Plenty Handipump

Handles a wide range of viscosities from gasoline to bitumen. Capable of many and varied applications.

Write for this fully descriptive leaflet, which tells how you can use Handipumps—profitably! A post card will do.

The Handipump is ideal for:

OIL FUEL UNITS
PRESSURE TESTING
DISPENSING
PRESSURE LUBRICATION

Plenty designs are registered and protected by world-wide patents.

RELIABLE — REVERSIBLE — SIMPLE — SELF-PRIMING

PLENTY & SON Ltd.

EAGLE IRON WORKS
Newbury, Berks
Telephone: NEWBURY 2363 (4 lines)
Telegrams: PLENTY, NEWBURY
E.N.

Insure

your **BOILERS** *against scale*
your **SUPERHEATERS** *against priming*
your **DOMESTIC WATER SUPPLY** *against salt contamination*
your **ENGINEERS** *against worry*

by fitting **Crockatt** **salinometers**

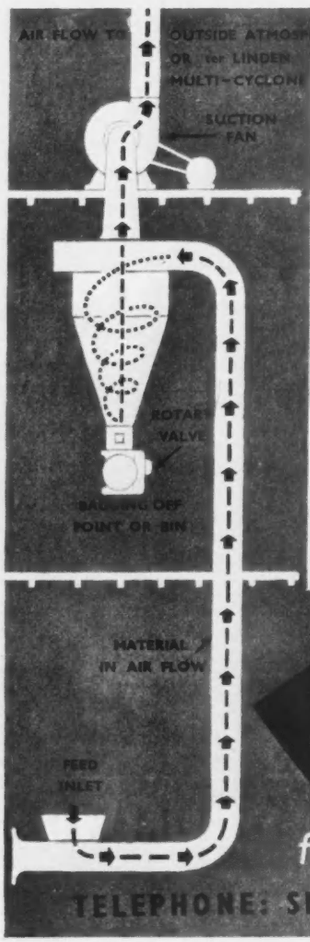
Single or Multipoint with or without automatic diversion of impure water

Crockatt manufactures include also
FEED WATER FILTERS
VALVE RESEATERS
BOILER TUBE CLEANERS
TERRAZZO and WOOD FLOOR SURFACING MACHINES
MACHINE CUT GEARING
SPECIAL MACHINES TO CUSTOMERS' REQUIREMENTS

Thousands of instruments in service in
NAVAL VESSELS, PASSENGER LINERS, TANKERS — (TURBINE and DIESEL) WHALERS—CARGO SHIPS—and INDUSTRIAL PLANTS

we will gladly submit our proposals to meet your requirements

W. CROCKATT & SONS LTD.
64 DARNLEY STREET, GLASGOW, S.1.



LIVERPOOL CALLOW DUSTLESS AIR CONVEYING

Write for details and technical representative to call

F. E. CALLOW
ENGINEERS LIMITED
BIRCHILL RD. KIRKBY TRADING ESTATE
LIVERPOOL ENGLAND

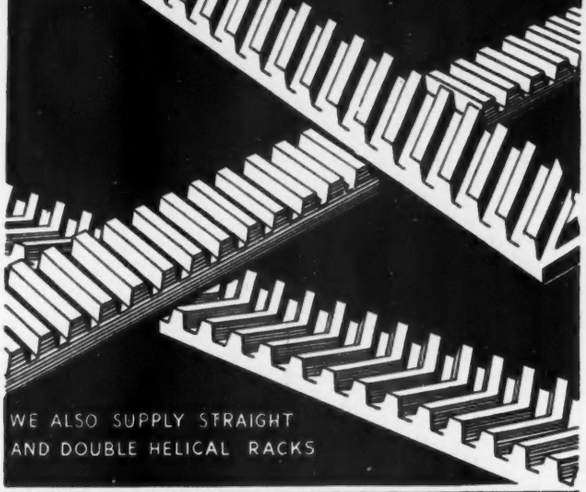
for fine milling

TELEPHONE: SIMONSWOOD 2461-2

Specify HELICAL RACKS

OF GUARANTEED ACCURACY TO IMPROVE YOUR PRODUCT.

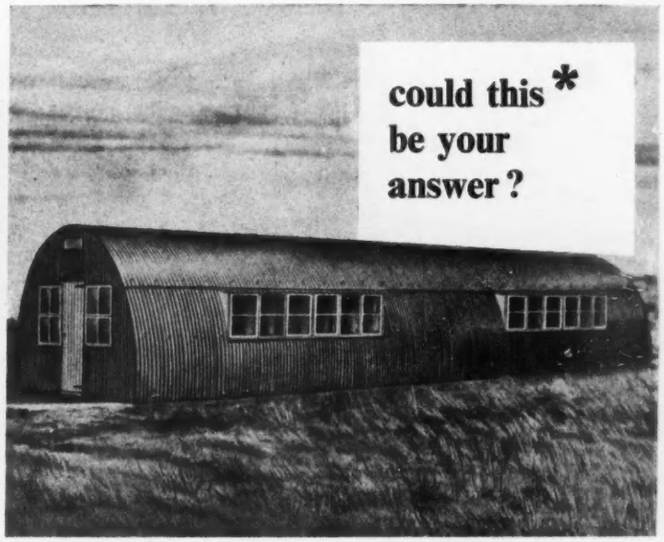
UP TO 2" PITCH, ANY LENGTH.



WE ALSO SUPPLY STRAIGHT AND DOUBLE HELICAL RACKS

BARLOW & CHIDLAW LTD

PENDLETON · MANCHESTER. 6.



* Tomorrow may find you facing a complex building problem demanding an urgent or economical solution. For a speedy, efficient answer, use THORNS CURVED ROOF BUILDINGS, which provide the most inexpensive form of building construction, great adaptability, and ease of erection. Illustrated is a Nissen-type shed, size 48ft. × 16ft.

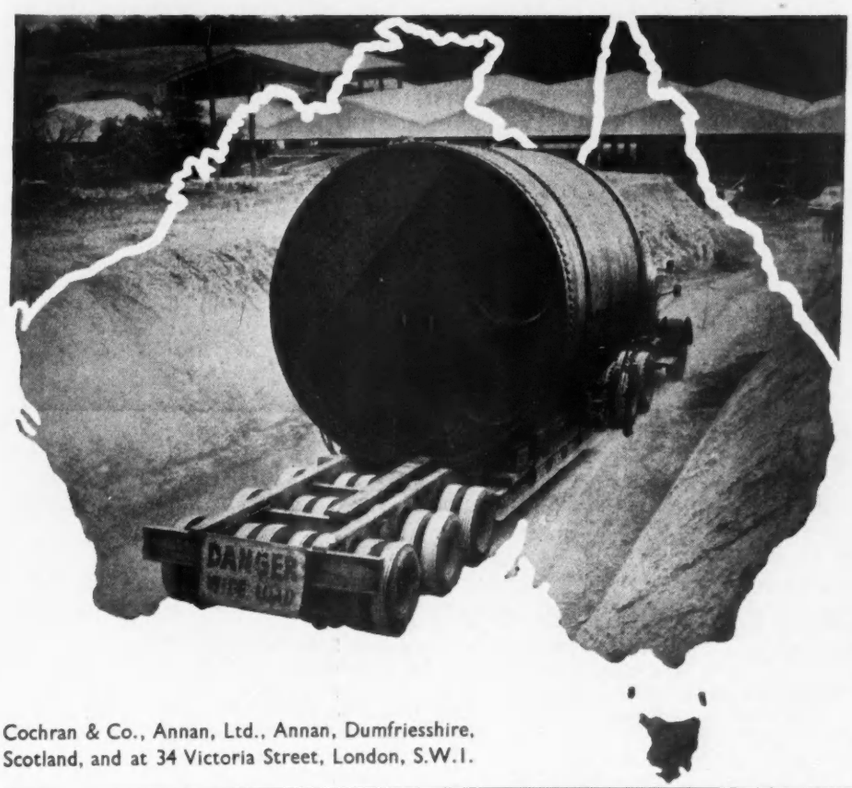
Other widths available—16ft., 24ft., 30ft., 35ft., 91ft.

get your quotation from THORNS

J. THORN & SONS LTD. (Dept. 81), BRAMPTON ROAD, BEXLEYHEATH, KENT

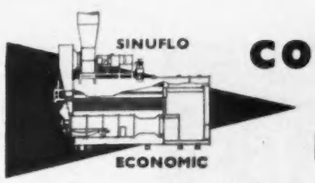
BD 155

COCHRAN 'DOWN UNDER'



An 11′ 9″ diameter Cochran Sinuflo Economic boiler arriving at the factory of Thomas De La Rue (Aust.) Pty., Ltd., in Thornleigh, New South Wales. Here in Australia, as in the rest of the world, the particular features of this type of boiler are appreciated by the experienced user.

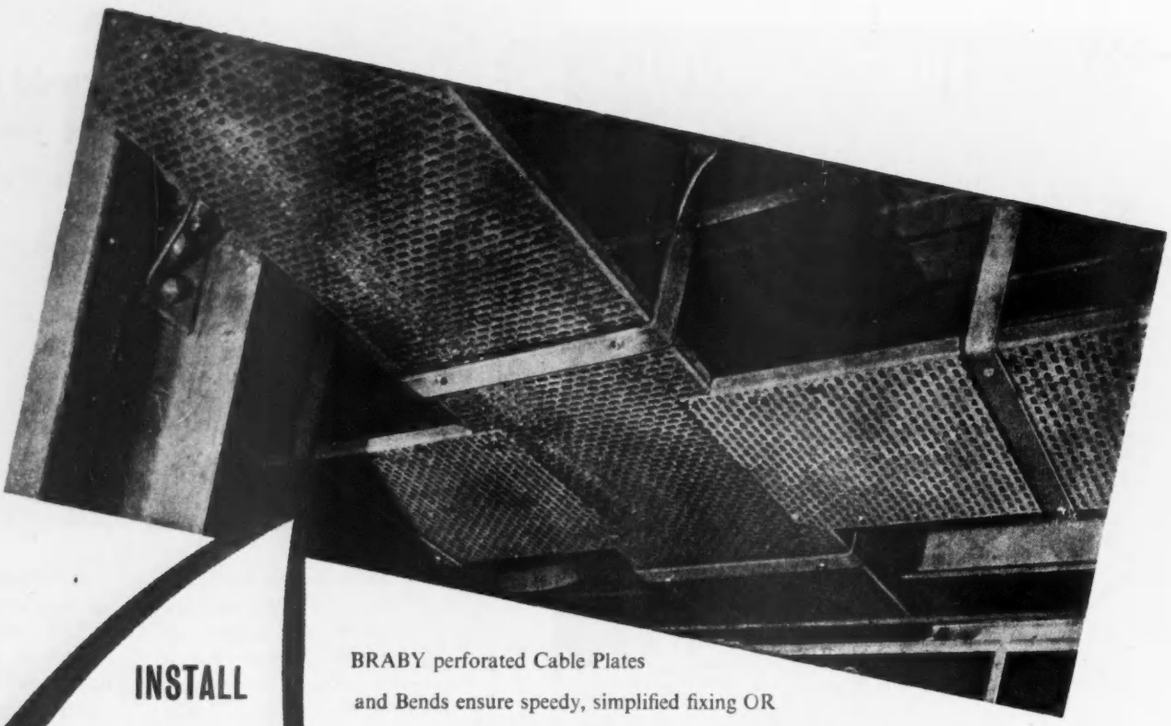
Cochran Sinuflo Economic boilers are designed and built to give long service, *continuous* high efficiency, full accessibility to all water surfaces and convertibility from solid to liquid fuel-firing and vice versa.



COCHRAN BOILERS

Cochran & Co., Annan, Ltd., Annan, Dumfriesshire, Scotland, and at 34 Victoria Street, London, S.W.1.

TAS. CH.607

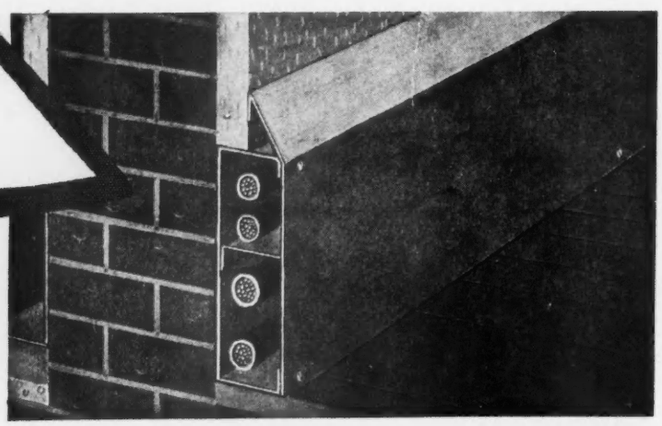


INSTALL
CABLES
EFFICIENTLY
AND SPEEDILY with
BRABY
CABLE ACCESSORIES

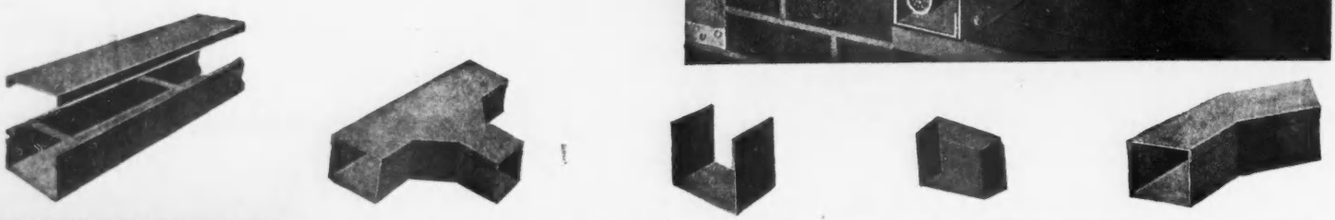
BRABY perforated Cable Plates and Bends ensure speedy, simplified fixing OR removal of Cables. The plates and bends can be supplied in mild steel—self colour, painted or galvanized after manufacture, or plastic coated. Also supplied in aluminium alloy.

BRABY mild steel Trunking protects and conceals cables.

BRABY Cable Accessories are particularly suitable for installations requiring frequent alteration and are widely specified for hospitals, factories, schools, cinemas, offices and in the shipbuilding industry.



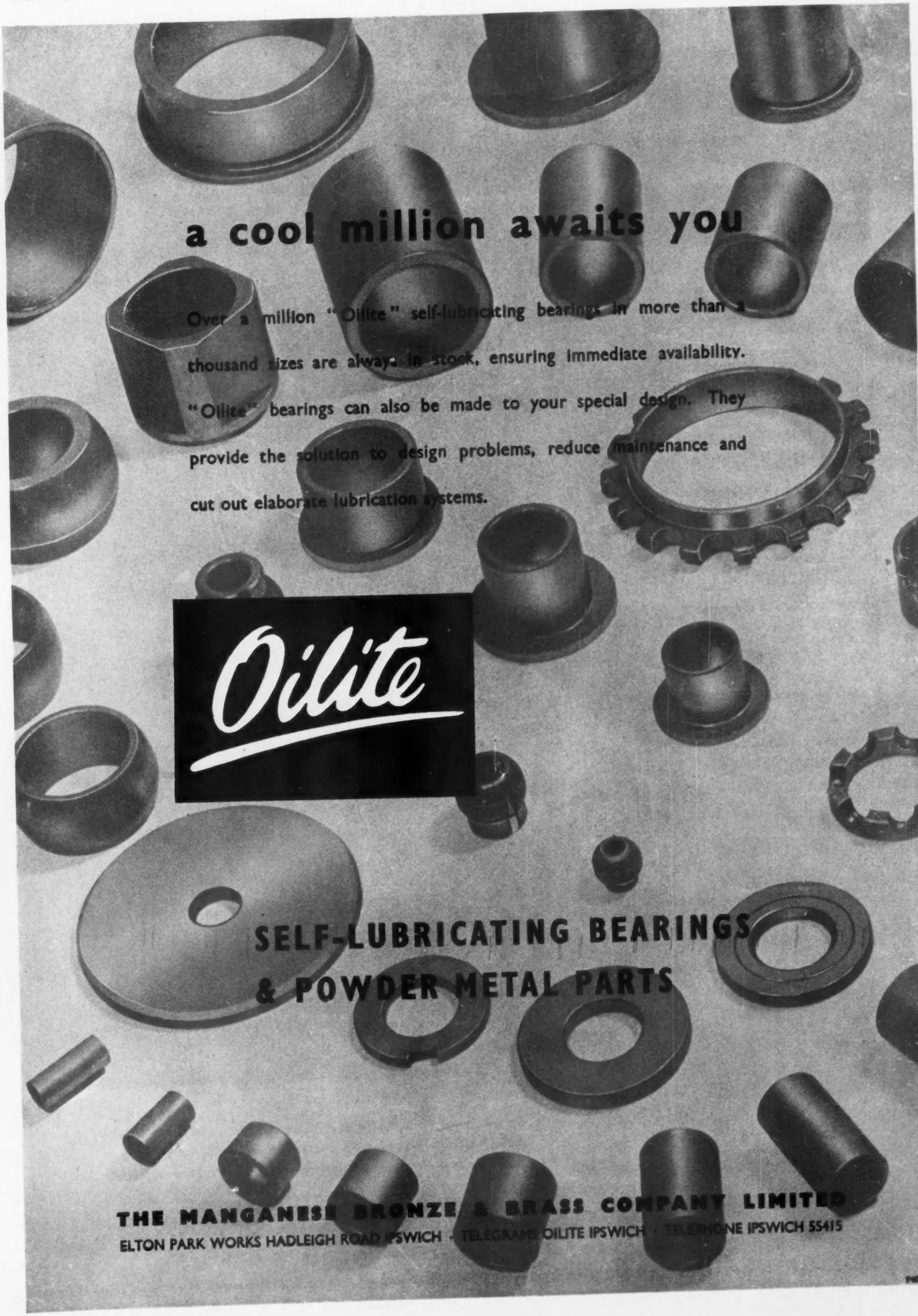
Prices and leaflets giving fuller details on application.



ONE OF THE WIDE RANGE OF
BRABY
PRODUCTS

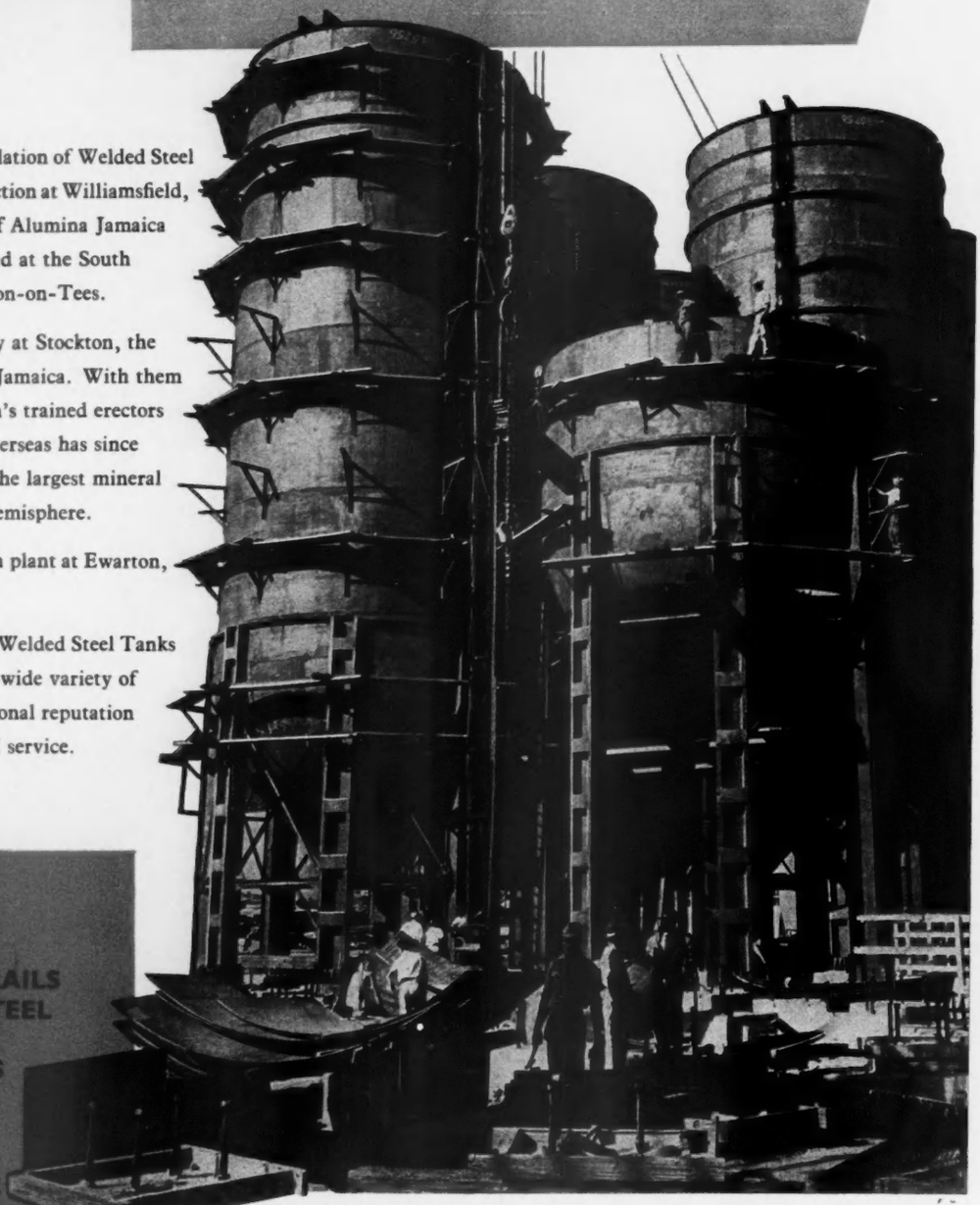
FREDERICK BRABY & COMPANY LIMITED
LONDON WORKS, THAMES ROAD, CRAYFORD, KENT. TELEPHONE: BEXLEYHEATH 7777
OTHER FACTORIES AT: Havelock Works, Aintree, Liverpool, 10. TELEPHONE: Aintree 1721
Eclipse Works, Petershill Road, Glasgow, N. TELEPHONE: Springburn 5151
Ashton Gate Works, Bristol, 3. TELEPHONE: Bristol 64041. And Falkirk
OTHER OFFICES: 352-364 Euston Road, London, N.W.1. (Head Office). TELEPHONE: EUSton 3456
110 Cannon Street, London, E.C.4. (Export). TELEPHONE: MANsion House 6034
Queen's Buildings, 10 Royal Avenue, Belfast. TELEPHONE: Belfast 26509
Palace Street, Plymouth. TELEPHONE: 62261

AP378


a cool million awaits you
Over a million "Oilite" self-lubricating bearings in more than a thousand sizes are always in stock, ensuring immediate availability. "Oilite" bearings can also be made to your special design. They provide the solution to design problems, reduce maintenance and cut out elaborate lubrication systems.
Oilite
SELF-LUBRICATING BEARINGS & POWDER METAL PARTS
THE MANGANESE BRONZE & BRASS COMPANY LIMITED
ELTON PARK WORKS HADLEIGH ROAD IPSWICH · TELEGRAMS OILITE IPSWICH · TELEPHONE IPSWICH 55415

STEEL PRODUCTS OF INTERNATIONAL REPUTE

South Durham in JAMAICA



Here is one small part of an installation of Welded Steel Precipitator Tanks in course of erection at Williamsfield, Jamaica, at the Kirkvine Works of Alumina Jamaica Ltd. The tanks were manufactured at the South Durham Malleable Works, Stockton-on-Tees.

After fabrication and test assembly at Stockton, the component parts were shipped to Jamaica. With them went a full crew of South Durham's trained erectors and welders whose tour of duty overseas has since covered the installation of one of the largest mineral processing plants in the western hemisphere.

Work on a similar Alumina Jamaica plant at Ewarton, is now nearing completion.

All over the world, South Durham Welded Steel Tanks and Pressure Vessels are serving a wide variety of industries and maintaining the national reputation for high quality products and good service.

Other South Durham manufactures include:
STEEL PLATES · STEEL RAILS AND ACCESSORIES · STEEL JOISTS AND SECTIONS
BROAD FLANGE BEAMS
LARSSEN STEEL PILING
'RENDHEX' FOUNDATION COLUMNS · STEEL PIPES
STRUCTURAL STEELWORK
ELECTRICALLY WELDED FABRICATIONS

The services of the South Durham Technical Advisory and Drawing Office Staffs are available at all times to engineers engaged in the planning or development of projects involving the use of any of the Company's products.

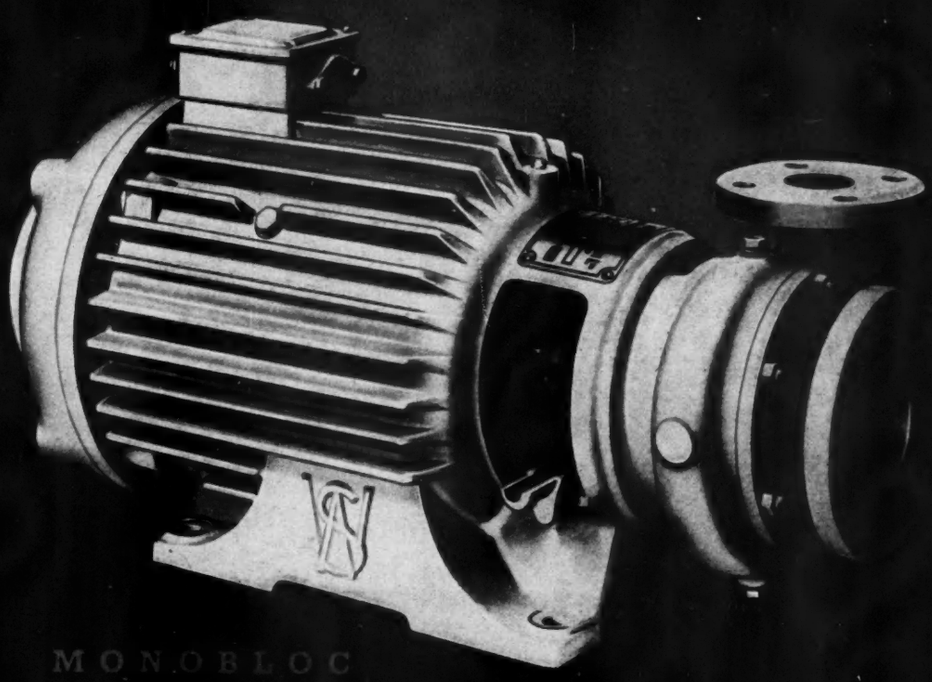
SOUTH DURHAM STEEL AND IRON COMPANY LIMITED

Central Sales Office: CARGO FLEET IRON WORKS, MIDDLESBROUGH, YORKS.

Telephone: Middlesbrough 2631 (14 lines). Telegrams and Cables: "Carfleco," Phone, Middlesbrough. Also at West Hartlepool, Stockton-on-Tees and London.

NEW chemical resistance

Worthington-Simpson pumps in WORTHITE, superior alloy steel, offer full corrosion resistance to sulphuric and many other acids and alkalis. For pumping mildly corrosive liquids, 18 & 3 Stainless Steel is specially suitable and it will not contaminate or discolour non-corrosive liquids. This range of pumps is of cost-saving Monobloc construction, and the pumps themselves have interchangeable stuffing box glands and mechanical seals to permit simple changes to suit different processes.



MONOBLOC

CHEMICAL PUMPS

in WORTHITE and 18/8/3 STAINLESS STEEL

Here are just a few of the many liquids which these pumps will handle effectively and safely

Sulphuric Acid
Acetic Acid, glacial
Acetic Anhydride
Acetone
Alcohols
Benzoic Acid
Boric Acid, cold
Butyric Acid
Calcium Bisulphite
Caustic Potash, 70°F
Caustic Soda up to 50%
Chlorosulphonic Acid, 120°F (pure)
Chloroform
Copper Sulphate
Ethyl Acetate, 70°F
Fatty Acids
Formaldehyde, 70°F
Glycerine
Magnesium Sulphate, 5%, 70°F
Nitric Acid, all concentrations
Oleum, up to 120°F
Phosphoric Acid, 10%, 70°F
Phosphoric Acid, 85%, 70°F
Refinery Crudes
Silver Nitrate, 70°F
Sodium Sulphate, 5%, 70°F
Sodium Sulphide, 5%, 70°F
Sodium Sulphite, 5%, 70°F
Sulphurous Acid

Worthington - Simpson LTD NEWARK NOTTS

put it to the test

write for WORTHITE & 18/8/3 specimens. Duty and test them under your own site conditions.

P659/LO.1674

COLD ROLLED STRIP

(MILD, MEDIUM and HIGH CARBON),

BRIGHT STEEL BARS and WIRE,
'TRUBRITE' STAINLESS STEEL.

QUALITY CARRIES THE DAY

That's a good reason for having a word with LEE if the products you manufacture call for Steel Strip, Bars or Wire.

As it pays *us* to produce only materials of the highest quality and consistency, so it will pay *you* to use them because of the added prestige and sales they will bring you. *Write or 'phone now*

LEE

of Sheffield

ARTHUR LEE & SONS LIMITED

TRUBRITE STEEL WORKS · MEADOW HALL · SHEFFIELD
Telephone : Sheffield 387272

London Office: Stafford House, 40/43 Norfolk St., Strand, W.C.2. Tel: Temple Bar 7187/8
Birmingham Office: 191 Corporation St., Birmingham 4. Tel: Central 6801/2

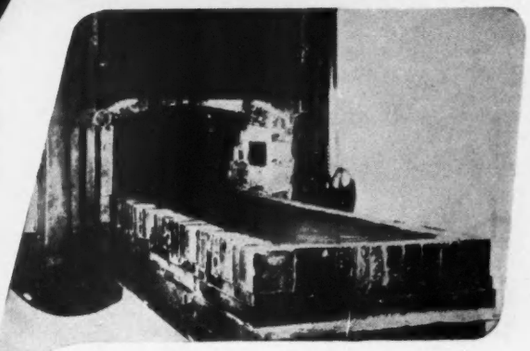
C851+1

BOGIE TOPS

Examples of another of the many uses for

REFRACTORY CONCRETE

Atlas Steel Foundry. Bogie for mould drying stove, topped with Refractory Concrete. Bogie is 25′ long and 10′ wide, the topping being 6″ thick. The door shown is lined with Ciment Fondu insulating concrete



Wm. Jessop & Sons Ltd. Bogie is 15′ long by 5′ wide topped by 6¼″ of Refractory Concrete

—Because its monolithic construction eliminates troubles due to displacement of bricks

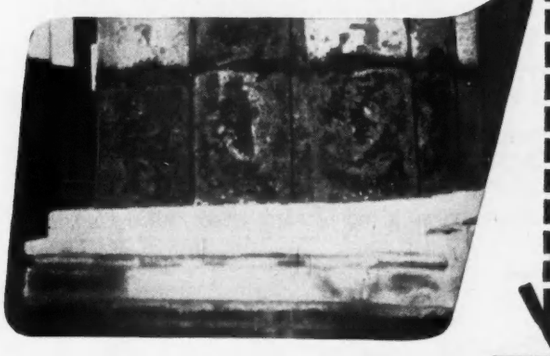
—It will withstand severe thermal shock without spalling

—It is ready for use and of great strength and hardness in 24 hours

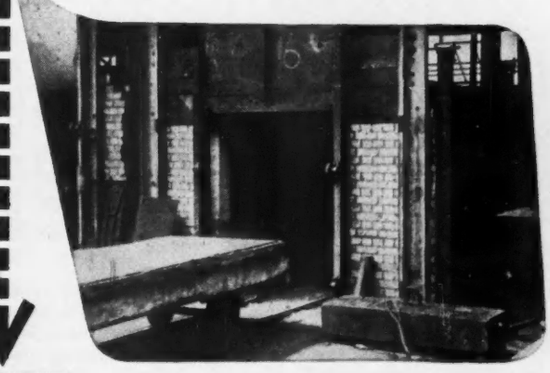
—It has no appreciable drying shrinkage or after-contraction

—It is stable under load up to 1300°C. (2400°F.)

Bogie used at large Northern Foundry, in gas-fired tunnel oven, for annealing malleable iron at 1050°C. Bogie is 7′ x 7′ and the Refractory Concrete decking is 12″ thick.



Crossley Bros. Ltd. Bogie for gas-fired annealing oven operating at 650°C. The door is also lined with Refractory Concrete



REFRACTORY CONCRETE
the adaptable Refractory material made with crushed firebrick and CIMENT FONDU

CIMENT FONDU
Regd. Trade Mark
ALUMINOUS CEMENT

The Cement for Industry
FOR SPEED · STRENGTH
RESISTANCE · REFRACTORINESS

Ciment Fondu is manufactured by
LAFARGE ALUMINOUS CEMENT COMPANY LIMITED
73, BROOK STREET, LONDON, W.1. Telephone: MAYFAIR 8546
You are invited to write for further details and photographic examples

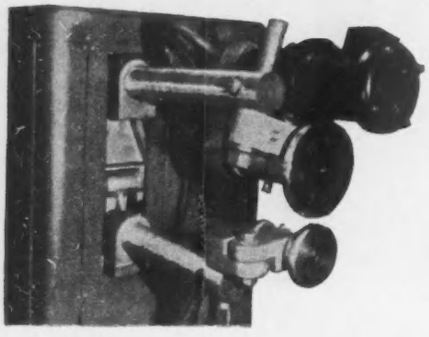
AP 3-1306

MERITUS

SEAM WELDING

on MERITUS SPOT WELDING MACHINES

all machines in our range are available for demonstration at our works at any time



Models from
5-60 KVA
Pedal or Air
Operated

MACHINES FOR SPOT, STITCH, BUTT & SEAM WELDING

MERITUS (BARNET) LTD.

BARNET, HERTS.

TELEPHONE : BARNET 2291/2

WOOTTON BROS. LTD.

COALVILLE IRON WORKS, COALVILLE Nr. LEICESTER

Clay Working Machinery for Brick and Pipe Works. Colliery Plant. Iron and Brass Founders and Cast Steel. Hammered Steel and Iron Forgings. Steel Stockists. Arc Welding. C.Y. Non Abrasive Alloys to Order.

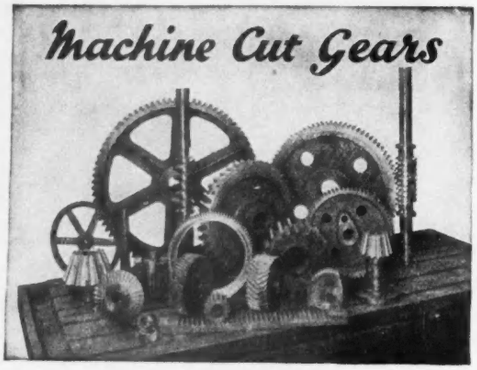
Established 1876

Telegrams: WOOTTON, COALVILLE. Telephone No. 22.

SPURS
BEVELS
WORM WHEELS
HELICALS
CHAIN GEARS

Complete Supply
Cutting only

Machine Cut Gears



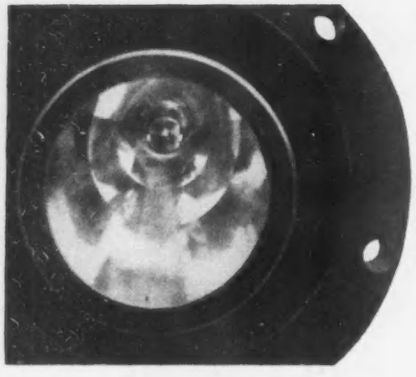
WORMS
RACKS
SCREWS
SILENT GEARS
CHANGE GEARS

All materials standard pitches to 7ft diameter

General machine castings made to customers' patterns. Low prices for planing, boring, turning, screwcutting
Send your enquiries to

GREENWOOD'S STANDARD GEAR CUTTING CO. LTD.,

New Bond Street, Halifax. *Telephone: Halifax 521/78* *Telegrams: "Gears."*



The "Monochromed" bore of a tube used in ice-cream making machinery.

MONOCHROME HARD-CHROME PLATING

we undertake the **PLATING OF ALL METALS** *(including aluminium and its alloys). Components up to 2 tons or 18ft. length accommodated.*

*our speciality—***HONEYCHROME** *patented*
OIL-RETAINING HARD-CHROME SURFACE PLATING

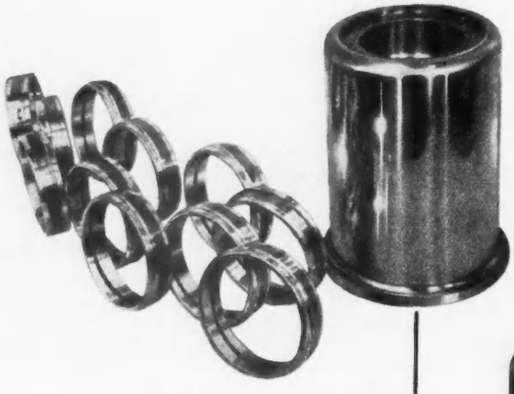
our capacity includes—
DEEP-HOLE BORING *up to 14ft. length.*
HONING *up to 30ft. length.*
GRINDING *(including roll grinding 15ft. length, 50in. dia.).*

MONOCHROME is the name given to our specialised process whereby the hardest and most highly corrosion resistant metal-chromium is directly applied to prescribed surfaces of components in all metals, including aluminium and its alloys (magnesium being the only exception). Monochrome plating has been applied with considerable advantage to parts of pumping equipment and marine machinery among countless other industrial applications where corrosion or frictional wear must be combated.

HONEYCHROME is the name given to a Monochrome patented process for prolonging the life of semi-dry bearings or similar parts subject to oil-starved operation. Components such as cylinder bores are provided with hard-chrome corrosion and erosion resistant surfaces uniformly patterned with a series of oil-retaining depressions of pre-determined size, pitch and depth.

We shall be pleased to advise you regarding any hard-chrome, silver or copper plating requirements, and our grinding, honing and deep-hole boring capacity is at your service.

INDUSTRIAL MONOCHROME PLATING

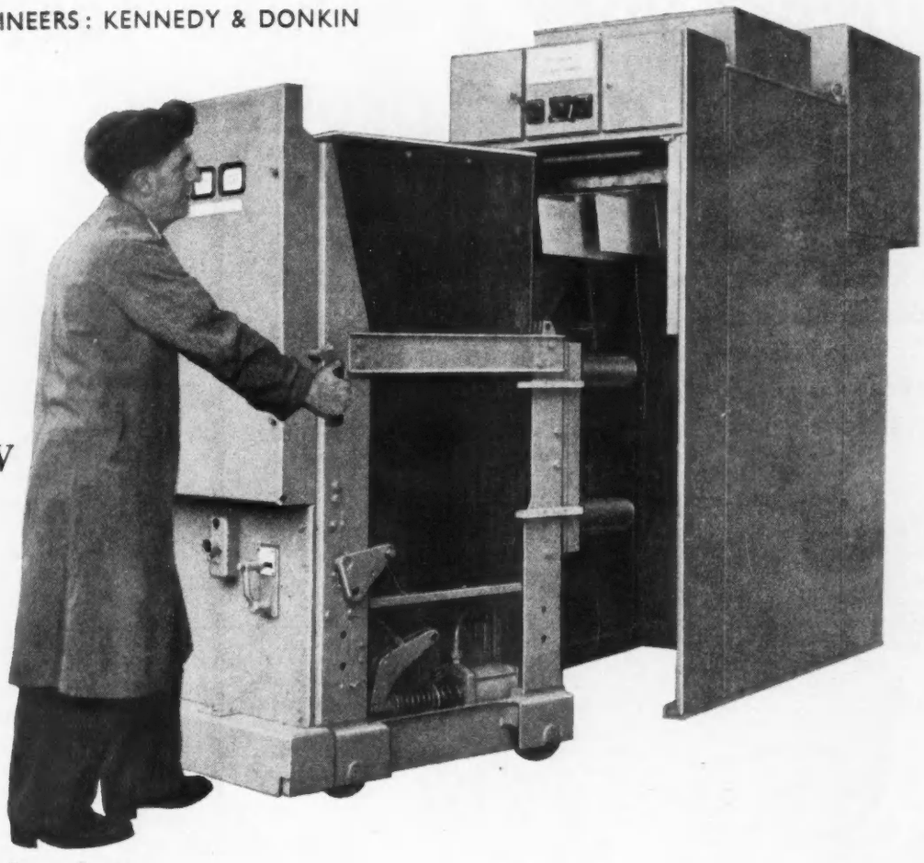


Capstan roller and spinning wheels: textile machinery parts "Monochromed" for greatly increased life.

A "Monochromed" piston used in hydraulic equipment.

MONOCHROME LTD · STUDLEY ROAD · REDDITCH · WORCS · STUDLEY 121

CONSULTING ENGINEERS: KENNEDY & DONKIN



The first 11-kV equipment incorporating an air-break circuit-breaker has been ASTA tested for a rating of 500 MVA.

A number of these equipments have been installed in the North of Scotland Hydro-Electric Board's St. Fillans power-station.

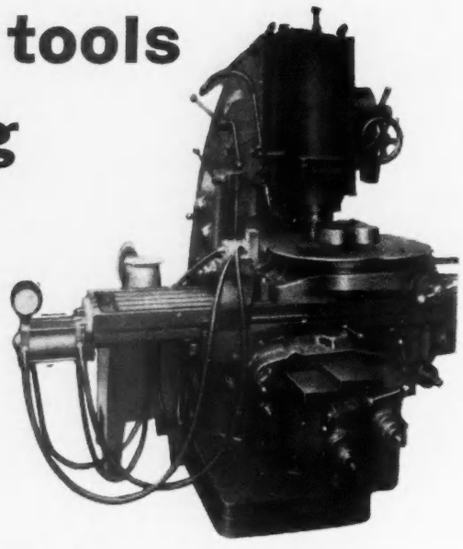
11-kV
500-MVA
AIR-BREAK
SWITCHGEAR

Reyrolle

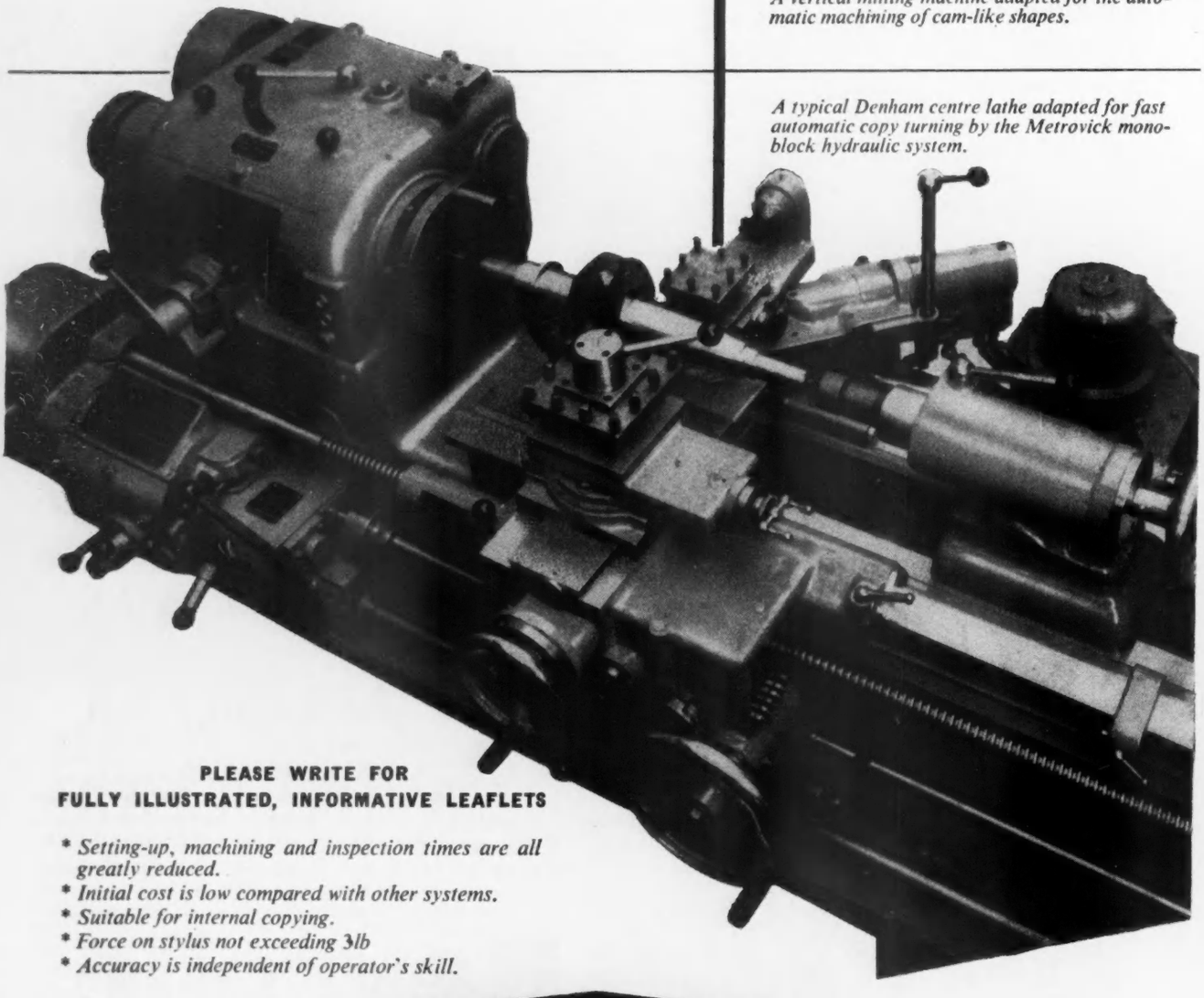
A. REYROLLE & COMPANY LIMITED HEBBURN · COUNTY DURHAM · ENGLAND

Convert your machine tools to automatic profiling

Centre lathes and machine tools of most types can be converted to fast automatic repetition work by means of the range of robust, reliable and economic hydraulic attachments made by Metrovick. Stepped shafts, tapers and intricate concave and convex shapes of every kind can all be turned with precision to match the contour of a master template or sample work-piece.



A vertical milling machine adapted for the automatic machining of cam-like shapes.



A typical Denham centre lathe adapted for fast automatic copy turning by the Metrovick monoblock hydraulic system.

PLEASE WRITE FOR FULLY ILLUSTRATED, INFORMATIVE LEAFLETS

* *Setting-up, machining and inspection times are all greatly reduced.*
* *Initial cost is low compared with other systems.*
* *Suitable for internal copying.*
* *Force on stylus not exceeding 3lb*
* *Accuracy is independent of operator's skill.*

METROPOLITAN-VICKERS
ELECTRICAL CO LTD TRAFFORD PARK MANCHESTER 17

An A.E.I. Company

METROVICK HYDRAULIC COPYING ATTACHMENTS

G/A 602

P.&W.MACLELLAN, LTD

CLUTHA WORKS
35 MACLELLAN STREET
GLASGOW S.1

STEEL BRIDGES
STEEL FRAMED BUILDINGS
STEEL RAILWAY WAGONS
TANKS
ELECTRIC WELDING
HYDRAULIC PRESSINGS
FORGINGS AND DROP STAMPINGS
RAILWAY AND GENERAL ENGINEERING

Telephone:
IBROX 1135 (4 lines)

Telegrams:
"MACLELLAN GLASGOW"

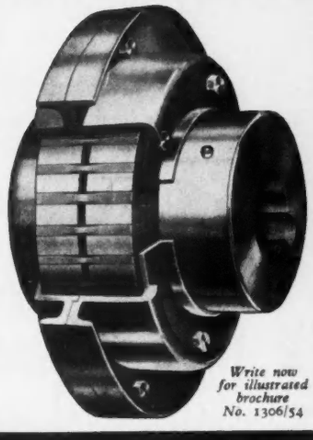
The Steel-Shaw Patent Flexible Coupling

THE SECRET IS IN THE DESIGN It is the shape of the springs—separate individual keys which give the high degree of efficiency.

Greater safety as stresses are equally divided. Perfect balance at all speeds. Rarely requires lubrication, as a lubricant is packed inside couplings.

Smaller total diameter to transmit a given torque than other couplings of similar type. Machined all over. Capacity from ·0125 to 24·80 B.H.P./R.P.M.

Diameter from 4½ to 38 ins.



Write now for illustrated brochure No. 1306/54

There's a STEEL-SHAW *answer to YOUR problem*

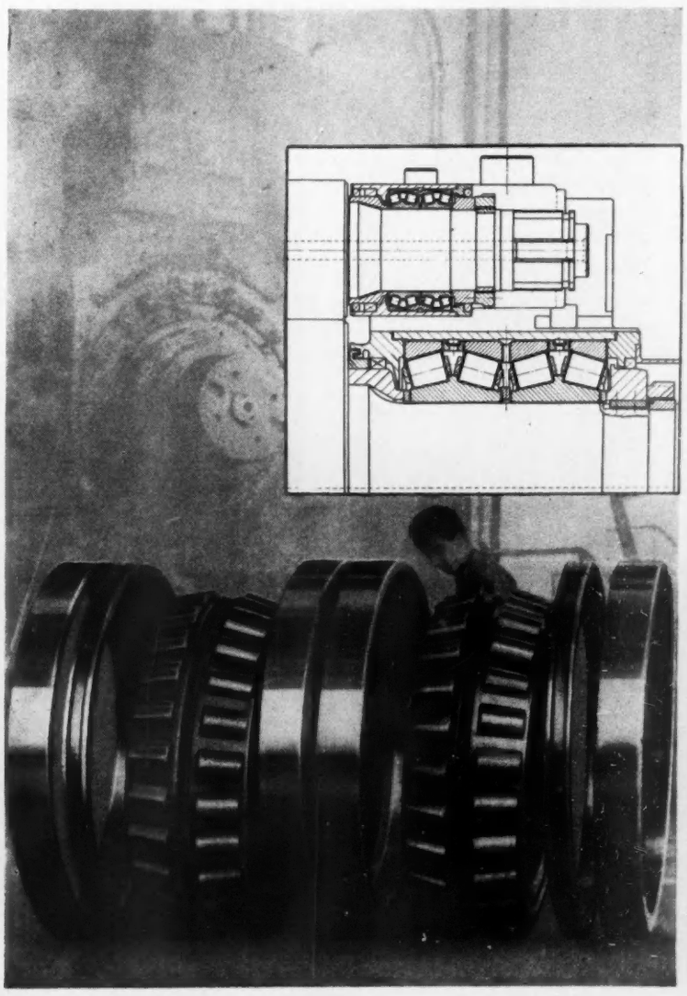
STEELE & COWLISHAW LTD., Dept. 16. Cooper Street, Hanley, Stoke-on-Trent
Telephone: Stoke-on-Trent 23333 (5 lines) Telex 36-530.
London Office: 329 High Holborn, W.C.1. Tel: HOLborn 6023

10532/SCL

RIV

mill bearings

The bearing illustrated, weighing approx. 4,000 kgs., has overall dimensions 800 m/m I/D x 1,280 m/m O/D x 780 m/m wide.



RIV BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER **BEARINGS** IN INCH AND METRIC SIZES

RIV *Bearings are manufactured by* **RIV,** *Officine di Villar Perosa, S.p.A., Turin, Italy.*

SOLE CONCESSIONAIRES IN THE UNITED KINGDOM AND EIRE

REVOLVO LTD.

399/405 Edgware Road, London, W.2. Tel: PAD 4087/8/9

Taking things easy...

Metalrax Gravity Roller Conveyors ensure that the work runs smoothly, effortlessly. They take a load off your mind—as well as off the strength of your staff.

METALRAX

Gravity

ROLLER CONVEYORS

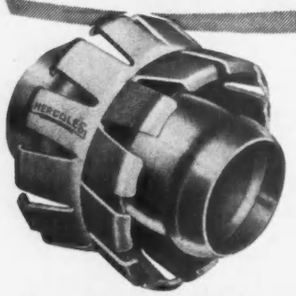
do the carrying

The moderate cost of METALRAX Gravity ROLLER CONVEYORS is very soon repaid in time gained and labour saved. The wide use of these better-made conveyors by important organisations everywhere is proof of efficiency. Send for current list which gives full details of sizes and prices, straight sections, standard bends and adjustable stands.

JAMES OSCARD & CO.

Dpt. E. 139, WHITTON RD., TWICKENHAM. Tel. POPesgrove 5281

If you use Hose.. HERCULES REPAIRERS *save time and money!*



Our wide range includes Hose Repairers for all types of industrial hose, ¼"—2", Screw Couplings ¼"—1", etc.

HERCULES HOSE FITTINGS need no clips, clamps, wires or special tools. Their positive grip is provided by special Claws —which are merely hammered down. Wherever hose is used, Hercules fittings save time and money.

HERCULES
SIMPLY HAMMER IT

HOSE FITTINGS

NEWTON SALES COMPANY LTD.

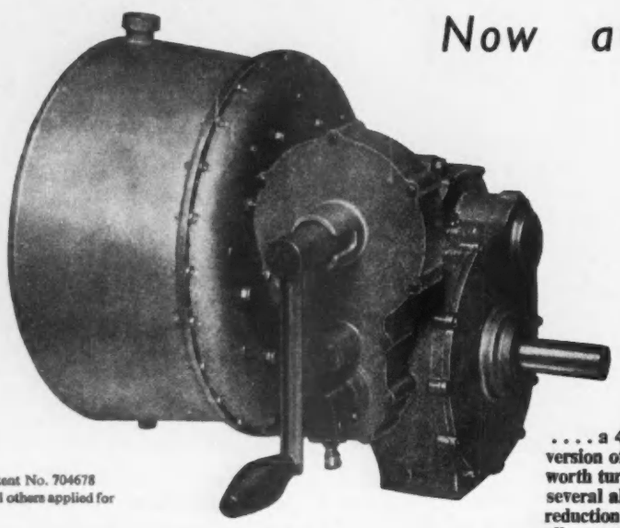
517, FULHAM ROAD, LONDON, S.W.6.

Tel: FULham 4228.

THE SPECIALISTS IN HOSE FITTINGS.

BUDWORTH *gas turbines*

Now available for—



Patent No. 704678 and others applied for

.... a 45/60 h.p. version of the Budworth turbine with several alternative reduction gears for all portable and other power requirements.

Alternators
Fire pumps
Land drainage and salvage pumps
Hydraulic pumps
Ships' generators and auxiliaries
High speed motor boats
Air compressors
Ventilating fans
Propeller turbine for light aircraft
Aircraft H/F generators

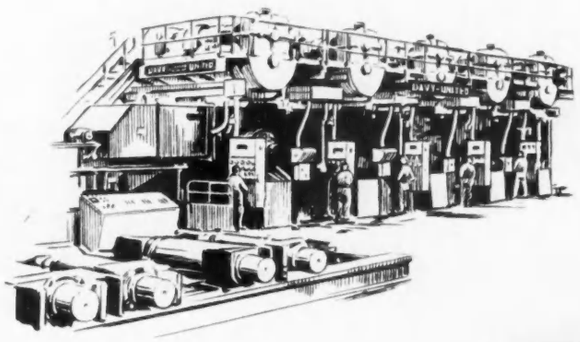
Also available as an air compressor, for ventilating and heating purposes, and for processes where a large supply of hot air may be required.

These hand-started gas turbines are without electrics, will burn diesel oil, paraffin, or petrol without alteration, have the highest power/weight ratio of any small gas turbine, and need virtually no maintenance.

There is no ducting, and for higher powers multiple installations of the basic turbine unit can be built up.

Please write for further particulars or demonstration

DAVID BUDWORTH LTD. - ENGINEERS - HARWICH - ESSEX - TEL 116



The latest techniques in the rolling mill

demand the latest techniques in roll making

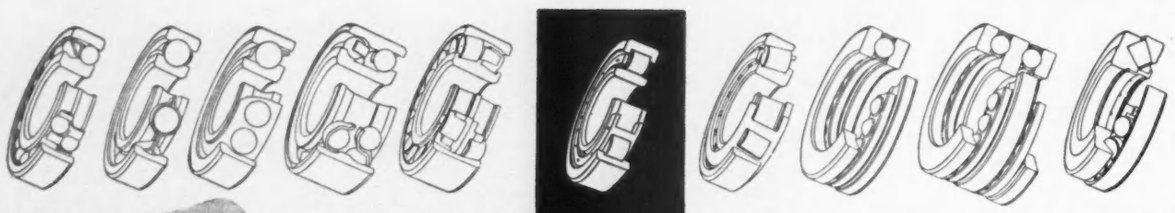
by

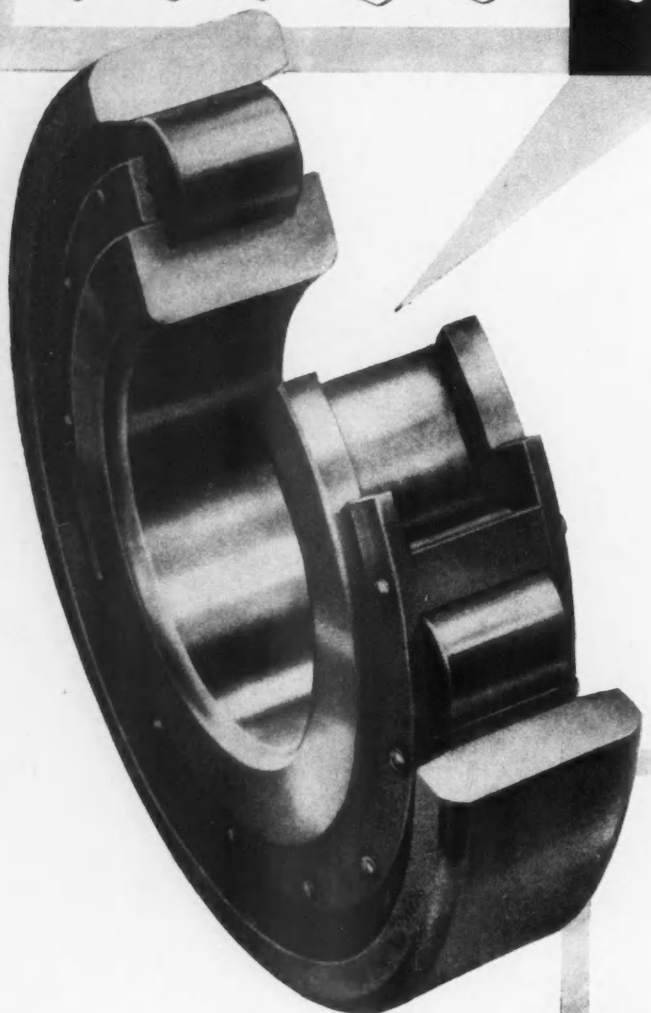
FIRTH BROWN

ALLOY STEELMAKERS • FORGEMASTERS • STEEL FOUNDERS • HEAVY ENGINEERS

THOS FIRTH & JOHN BROWN LIMITED • SHEFFIELD • ENGLAND

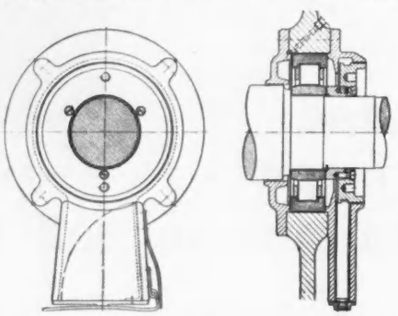
Only SKF can offer such a wide selection of British made bearings





Illustrated on the left is the SKF cylindrical roller bearing, one of the ten variants of the four basic types of rolling bearing manufactured in Great Britain by The Skefko Ball Bearing Co. Ltd. The cylindrical roller bearing has a low coefficient of friction and is therefore suitable for shafts operating at high speeds. Because of its high radial carrying capacity it is extensively used in electric motors, gearboxes and similar applications.

Behind every SKF bearing lies unrivalled experience in the design and application of rolling bearings all over the world. This experience is at your disposal from any one of Skefko's twenty Branch Offices, situated at strategic points all over the British Isles.



Bearing housing for an electric motor, incorporating a cylindrical roller bearing and a grease valve.

THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G 170

THE ENGINEER

No. 5328 MARCH 7, 1958 VOL. 205

OIL ENGINE EVOLUTION

It is related of a celebrated zoologist that once, when asked to give a lecture on fishes, he declared it to be a thing impossible ; he could not give a lecture on fishes but he would be pleased to give " a course of lectures on a fish scale." We are reminded of this episode when reading the account of any epoch in technical history and there has just reached us a paper with the title " Engine Evolution : Non-marine Engines Over a Quarter of a Century," contributed to the Diesel Engineers and Users Association on February 20 by Mr. D. S. D. Williams, A.M.I.Mech.E. This paper surveys the evolution which has taken place in the British heavy-oil engine industry (excluding marine engines) during the period 1933-58. In addition to surveying the range of applications, Mr. Williams deals with certain of the social factors which necessarily have come under review and he also includes a section covering design and components. The paper, copiously illustrated, is made the more informative and useful for reference by a number of tabulations relating to engine types, production data and exports.

To anyone looking towards the technical horizon in 1933 it must have seemed that whatever else might be doubtful, there was surely a very big future for the compression-ignition oil engine. It had already been adopted as standard by a number of engine builders and it is on record that by the end of 1930 there were approximately ninety heavy-oil-engine vehicles in use on the roads of Great Britain. It was in the same year that the then London General Omnibus Company put into service a six-wheeled omnibus fitted with a compression-ignition engine of indirect-injection type giving an output of 120 b.h.p. at 2000 r.p.m. An observer in 1933 would certainly have been on firm ground in prophesying a massive development in the field of compression-ignition oil engines but hardly such an avalanche as that detailed by Mr. Williams. While it is from analysis of the evidence available at the end of a period such as twenty-five years that we are most likely to get authentic indications as to future trends, Mr. Williams is to be commended for his avoidance of any dogmatic pronouncements as to the future. He finds one of the " outstanding characteristics " of the quarter of a century with which he deals to be " the greatly increased rating obtainable from an engine of given weight or bulk." He also points out that " increase in crankshaft speed has played a great part in development and in widening the scope of application of oil engines . . . Maximum mean piston speeds have accordingly risen from what was a fairly high value of 1400ft per minute in 1933 to industrial engine maxima of a common value somewhat under 2000ft per minute." Regarding values of brake mean effective pressure, it is shown that whereas twenty-five years ago industrial four-stroke units were commonly supplied for a maximum of around 75 lb per square inch, there has been a constant increase in brake mean effective pressure, " pressure-charging taking industrial engine values up to 130 lb per square inch, and when charge cooling became more recognised, 140 lb per square inch was encountered in catalogues, whilst to-day 160 lb per square inch is an occasional British value." After reading this we are not surprised to note how, at the present time, " some manufacturers are engaged in the re-design of frames and bedplates to permit higher values of brake mean effective pressure than 150 lb per square inch. These will be demanded in the years to come ; scantlings will be more robust, as the designs will have to hold good for several stages of up-rating." In this connection it is mentioned that " Sales resistance to pressure-charging plus cooling is steadily weakening, as users find out that the extra power is obtained without sensible increase in the exhaust temperature." While indicating the trend of the present and the immediate future as regards speeds and ratings, Mr. Williams has not omitted to sketch the impact on design and components, a large section of the paper being devoted to these matters. Not to be overlooked is a paragraph relating to " Maintenance " which follows close on the particulars describing the onset of pressure-charging and charge-cooling. It seems to us to strike a very practical note in reminding readers that " so long as human beings are behind machinery, so long will upkeep and maintenance be with us." As a procedure likely to lessen the hazards due to scarcity of skilled workshop staff, Mr. Williams calls attention to the " part (or assembly) replacement principle " as an alternative to rectification on site. " Whether the removed item is repaired locally, sent away for specialised treatment or is scrapped, the method raises capital charges but usually reduces running costs, as drivers or semi-skilled men only need be employed." The effect on capital charges will certainly increase rapidly with engine size and the reference is doubtless to the smaller units. We cannot doubt that whatever attention is given to the " replacement principle," consideration must also be directed to all means whereby the work of the station personnel can be simplified and everything in and associated with the engine rendered as trouble-free and fool-proof as possible. The greater the success attained in easing the job of running and maintenance the brighter must be the credit reflected on the engine manufacturer. This is something particularly worth while and we cannot doubt that British engine builders will regard it as a major objective. That Mr. Williams is himself of this opinion is confirmed by the following words—which will be read with applause by engineers at home and abroad—found in the section on " Maintenance " : " A deplorable tendency is designing in such a way as to need special tools too often. Boxes full of special maintenance gadgets may denote that a designer's head is insufficiently full of experience." The experience contained in a designer's head has a determining influence on the history of his product and success in engine manufacture is largerly founded on that sense of proportion which, ever the mark of the good engineer,

may be defined as the product of experience and common sense. How true are the words of the eighteenth century poet :

" Experience joined with common sense,
To mortals is a providence."

ESTIMATES FOR THE ARMED FORCES

A year ago the Government decided to increase Britain's contribution to the Allied deterrent and to reduce the strength of its Armed Forces by 50 per cent. The nation welcomed this new policy because it was to result in the abolition of national service ; but the subsequent realisation that it also meant the installation of sites for launching ballistic rockets near their homes has considerably damped popular enthusiasm. This year's Defence White Paper gave no indication of any change in policy and the estimates for the Fighting Services are thus, in the main, a detailed account of the reductions and economies in the Armed Forces achieved during the past year. Measures common to all three Services are the abolition of certain commands ; the closing down of many shore establishments ; and reductions in the number of civilians while employing them, whenever practicable, for tasks hitherto performed by uniformed personnel. Net Navy Estimates at £339,400,000 show an increase of nearly £23,500,000 on last year, but if allowance is made for increased costs of pay, material and transport, the Admiralty's spending power in terms of 1957 values is in fact £6,000,000 less than in 1957–58. The net Air Estimates at £467,050,000 show a reduction of over £20,500,000 on last year and Army net Estimates at £401,900,100 are only half a million more, despite losing £15,000,000 of appropriation in aid.

The most significant naval economy—which only becomes apparent by comparing the strength of the Fleet with last year's Estimates—is the reduction in the cruiser strength from nineteen to fourteen. The " Glasgow," " Liverpool," " Bellona," " Cleopatra," and " Dido " are no longer included and one must assume that they are to be sold or transferred to other navies. Three of the second line 24-knot " Glory " class carriers are also no longer on the list. Fourteen cruisers—the first of the three " Tiger " class will not be ready until the end of this year—are of course more than sufficient to provide a total of two cruisers for the Atlantic and Mediterranean area, where the contribution to NATO is mainly in the anti-submarine role, and one for the Fleet east of Suez. But when the First Lord emphasises the extent of our responsibilities in the East—from Aden to Hong Kong and from Mombasa to New Zealand—it is difficult to understand how one unit can meet our cruiser requirements in that area. Why not frankly admit that if Britain is to build up the deterrent, she cannot afford either the men or the money to maintain more than three cruisers in the active Fleet ? Other economy measures—which are much more desirable in that available naval resources are diverted from shore support to the fighting ships themselves—are the closing down of Sheerness and Portland dockyards ; of six naval air establishments ; and of the barracks and other naval establishments (but not the dockyard) at Chatham ; and the abolition of the Nore and East Indies Commands. Portland will still retain its naval base ; and all research and development establishments dealing with underwater weapons including the Torpedo Experimental Establishment, now at Greenock, will be concentrated there. Together with economies from the closing of Hong Kong and Trincomalee, these measures will save a total of 23,000 civilian posts, between 6000 and 7000 naval posts ashore and about £15,500,000 a year.

The Army—which has now adopted the brigade group as the most suitable basic formation—has also closed down fifteen major storage installations and two large workshops, and a further twenty-six installations are to be closed down during the coming year. The training of two surface-to-surface guided weapon regiments is well under way and the surface-to-air " Thunderbird " will be available for training during 1958. A proportion of the Army is being re-equipped with the British version of the FN rifle ; and the L2 sub-machine gun, which is now being produced in quantity, will progressively replace the Sten. The interim heavy anti-tank recoilless weapon for infantry units is being issued shortly and the development of a more advanced anti-tank weapon continues. The present level of personnel transport by air is being maintained at the rate of 60 to 65 per cent of the total movement (excluding Germany) and a new civilian organisation is being set up to replace the present military works organisation for the planning, execution and control of works. The Air Force, whose personnel strength on April 1, 1959 will be reduced to 174,000 from a strength of 228,000 in 1957, closed down ten operational stations at home and in Germany during the past year, in addition to ten units in Maintenance Command, a recruit school, a cookery school and a hospital. Four more operational stations are to be closed and several formation headquarters at home and overseas are being abolished. Aircraft of Bomber Command are being constantly exercised in a quick take-off in emergency, and the development of " stand off " bombs with a considerable range is proceeding satisfactorily. Flight refuelling equipment has been successfully tried out between Valiants and will now be tried out with Victors and Valiants in the receiving role. Trials of a complete weapons system should start soon at the first R.A.F. guided weapons station at North Coates and an operational deployment will follow. The Secretary of State emphasises that one must look to developments of surface-to-air guided weapons for anti-ballistic missile defence. The planned reduction of our fighter strength is to be completed during the coming year, but with the improvements in control and reporting system and the introduction of new equipment and better techniques, it is anticipated that fighters will now be able to meet a bomber attack at a far greater distance from home shores both by day and night.

TRANS-ANTARCTICA

For the first time on land—or rather on snow and ice—the Antarctic Continent has been crossed. On March 2, having spent ninety-nine days on the journey, Dr. Fuchs arrived at Scott base on the McMurdo Sound. He left Shackleton base some 2200 miles away on November 24, arrived at the South Pole on January 19 and left again on January 24. Undoubtedly the journey could have been completed more rapidly. But over the greater part of it much time each day was taken up by scientific observations, particularly of the thickness of the ice-cap. Forty-six years ago Amundsen with dog-drawn sledges and Captain Scott with man-hauled sledges reached the Pole. Dr. Fuchs also had dogs with him for part of the journey. But reliance was principally placed upon mechanical transport and the scientific purposes of the expedition could not have been performed and the weight of the equipment could not have been carried had not that transport been available. Elsewhere in this issue we describe some of

the vehicles which were used. Of the various mechanically propelled devices used the more successful seem to have been, judging by reports that have so far reached this country, the largest and the smallest. The "Sno-Cats," in particular, seem to have stood up remarkably to very severe hammering in covering crevassed areas and a great deal of this hammering occurred at the very outset of the whole journey on the section between Shackleton base and South Ice. But the performance of the Ferguson tractors which carried Sir Edmund Hillary to the Pole also proved remarkable even though the route traversed was apparently less difficult. We congratulate Dr. Fuchs and all those who took part in the adventure.

MACHINE TOOLS

Because it is a basic industry that of machine tools is always under criticism. Other such industries suffer in the same way. For example, the iron and steel industry is immediately criticised if its capacity to produce any product falls below demand for that product. It is firmly told that it should have foreseen the demand ! The facts that the foresight required might have had to extend over five years or more ahead, that it may have to relate to the business prospects of industries other than the steel industry itself, and that users would prove just as critical if very expensive excess capacity had been installed are all overlooked. Similarly the business and technical efficiency of electricity authorities would be called in question if power station capacity either fell at all below demand or substantially exceeded it. The supplier of a basic need, in fact, is exposed to criticism whatever he does, unless he can balance with precision on a tight rope. Of course he almost never can; yet it is astonishing, considering how far he is often asked to look ahead in planning extended capacity or improved products, how near he gets to balance.

It is good then, seeing how often the machine tool industry of this country comes under criticism, to read a brochure just produced by the Machine Tool Trades Association which gives facts and figures about the industry and which implicitly and explicitly replies to much of the criticism. For the production of machine tools is also a basic industry. It is often complained of that industry that it is failing to expand its output. Its production in 1954 was valued at £66,000,000. Last year the comparable figure, judging by the first six months' output, must have reached very nearly £100 million. Taking 115 representative firms between 1948 and the end of 1957 4,700,000 square feet of new buildings or extensions to plant were made and a further expansion of 2,000,000 square feet is planned to come into production by the end of 1960. Those figures hardly support the contention that it is failing to expand. Again the industry is often criticised for failure to produce particular kinds of tools, which then have to be imported. The answer, of course, is that no nation enjoys a monopoly of skill. As against these imports the industry exports some 30 per cent of its output. It is sometimes criticised for failure to adapt itself to fluctuating home demand. But it is pointed out that established export markets can only be held if they are properly supplied. Rightly or wrongly, it is the policy of the industry to satisfy fluctuations in home demand by varying imports not exports. Various other criticisms are similarly met.

But valuable and factual though the document is it does seem to us to have one fault. It reads too complacently. The undiscerning reader might well assume after reading it that none of the industry's critics were even nearly right ! It may, of course, be possible that the policies of the industry are indeed beyond criticism. Yet the brochure would have been more valuable had its compilers believed it possible they might be wrong and showed it in their writing.

ROSS SPUR MOTORWAY

The Ministry of Transport and Civil Aviation is keeping everybody well informed of each step in the road programme. On Monday, the Minister, Mr. Harold Watkinson, inaugurated work on the Ross Spur motorway, in a ceremony at Ross-on-Wye. We described this motorway scheme in outline in our issue of January 10, when the two contracts which are now under way were let ; the route of the road and the various firms and authorities concerned with it can be found in that article. Further reference, however, is topical, since the only motorway construction which has preceded it is in Lancashire, where the 8¼-mile Preston by-pass and the 12-mile Lancaster by-pass, both of which will eventually be incorporated in the North–South motorway, are being built.

The Ross Spur motorway will be 20 miles in length, when completed by the end of 1960, and will cost £6,000,000. It presents problems which will be to some extent typical of motor road construction in this country. As Mr. Watkinson pointed out at the ceremony, hazards and difficulties of sheer size which faced road builders in other parts of the world do not afflict us, but new roads would be built in one of the most densely populated and developed territories ; difficulties in providing access across, but separated from, the motorway, and of remodelling public utility services, were formidable. In the Ross scheme there are two major bridges, and considerable excavation and embankment construction. There will be nearly 1,000,000 cubic yards of excavation, about half of it in rock ; embankments will be up to 40ft high and cuttings up to 37ft deep. Initially, earth moving will proceed at a rate of about 20,000 cubic yards a week on one of the contracts. Bridge works, including the Queenhill bridge, will also be started upon immediately.

The Engineer — 100 Years Ago (MARCH 5, 1858)

"PUBLIC WORKS IN HOLLAND"

"Amsterdam, as is well known, is called a sea-port, although it is situated at a considerable distance from the North Sea. The natural access to Amsterdam is by the Zuy-der-Zee, but this small inland sea embanks itself so rapidly that it has been necessary to have recourse to an artificial canal of the length of eighty kilometres, which traverses the northern part of Holland, and joins Amsterdam to its port, Helder. This work has now been constructed twenty-five years, having been found indispensable to prevent the decay of Amsterdam, which would have resulted from the increasing number of difficulties in the navigation of the Zuy-der-Zee. The great north canal of which we speak having for a considerable length a draught of water quite inadequate to the actual necessities of the navigation, it has followed that ships, drawing a depth of water greater than the canal affords, have been compelled to discharge a portion of their cargo at Helder, and to be towed by horses a distance of 80 kilometres, which occupies several days.

"This state of affairs has now for a long time occupied the attention of Government, and several plans have been proposed. Those submitted by Messrs. Croker and Burn (English engineers) have received favourable reports from commissions specially appointed to investigate the subject ; but certain difficulties, more particularly the large expenditure upon forts and military works, have, up to the present time, delayed the execution of this very important undertaking. These difficulties appear now to have been overcome, and there are great hopes that this hydraulic work will be taken in hand and speedily completed. The point of the North Sea nearest to Amsterdam is at a distance of twenty kilometres. Messrs. Croker and Burn propose, by the carrying out of their plans, to join the Dutch capital to the North Sea by a direct canal 100 metres in width, and eight metres in depth."

Indentation and Forging and the Action of Nasmyth's Anvil

By W. JOHNSON*

Results are presented of the pressure required to indent a block of metal by three or more dies of equal width when symmetrically situated and the solution proposed is shown to be formally identical with extrusion through a smooth wedge-shaped die. Other solutions for various circumstances are also proposed for indenting and forging and approximate methods of analysis are described. The solutions throw light on forging in V-anvils and are shown to corroborate an observation first recorded by James Nasmyth who introduced them.

THE purpose of this article is to examine briefly certain aspects of the mechanics of forging and indenting with more than two and principally three dies, the writer's interest in the subject being stimulated on reading the autobiography of James Nasmyth, who claimed to be the first to depart from using a flat-faced anvil.[1] Nasmyth[1] is remembered as the inventor of the steam hammer, a device he was prompted to develop when consulted by a Mr. Francis Humphries, engineer to the Great Western Company, about machine tools of unusual size and power which were required for the construction of the immense engines of the proposed steamship, "The Great Britain." It transpired that for so large a ship the required size of the intermediate paddle-shaft—30in diameter—was so large that no firm in the country could undertake such a huge forging. At this time tilt-hammers were everywhere used, and the larger the work placed on an anvil the more it became "gagged." Nasmyth records that "in little more than half an hour after receiving Mr. Humphries's letter narrating his unlooked-for difficulty I had the whole contrivance . . . before me in a page of my Sketch Book . . . and the date of this first drawing was . . . 1839." The sketch Nasmyth reproduced shows a forging on a flat anvil only, and it was not until six years later that the V-anvil was introduced. This however is not surprising, since the first order received for his contrivance was only for use as a steam-hammer pile driver, and that in July, 1845.

Analysis

Consider the indenting of a comparatively long prismatical block of material using three dies of equal width, as in Fig. 1 (*a*), such that their centre lines are concurrent and 120 deg. apart. Since the block is long, the situation may be conceived as one to which a plane strain analysis is applicable, and is thus a problem to which the theory of slip-line fields may be applied.† When indenting takes place, displacement of material must occur symmetrically. On constructing the appropriate slip-line field one finds that this turns out to be a continuous peripheral region of plastically deforming material between the dies, and in Fig. 1 (*a*) such a region is indicated. Loosely speaking, these slip-line fields are regions in which large plastic deformations are imposed, and the remainder of the mass of material is not plastically deforming but subjected only to elastic stresses which cause no sizeable deformation. The slip-lines themselves are directions of maximum shear strain rate. The solution tacitly assumes that adhering to each die there is a triangular zone of dead metal or, alternatively, that the die acquires a false head of material which is perfectly rough. The nets of orthogonal slip-lines springing from the die corners intersect on the axes of symmetry between the die centre-lines, at 45 deg., at one point only. In the centre of the indented block there is a stationary mass of rigid material, whilst away from it on the outer sides of the bounding slip-line field there are three rigid regions, caused to move outwards along the axes of symmetry. The stress field proposed is only an acceptable one if, corresponding to the net of slip-lines, an appropriate hodograph can be determined. The hodograph is in effect a diagram which shows that the strain-rates at the various points in the mass of the material are compatible with imposed stresses and boundary displacements. It follows that from the hodograph the deformation of elements at various points in the block could be determined. Fig. 2 is the hodograph for Fig. 1 (*a*).

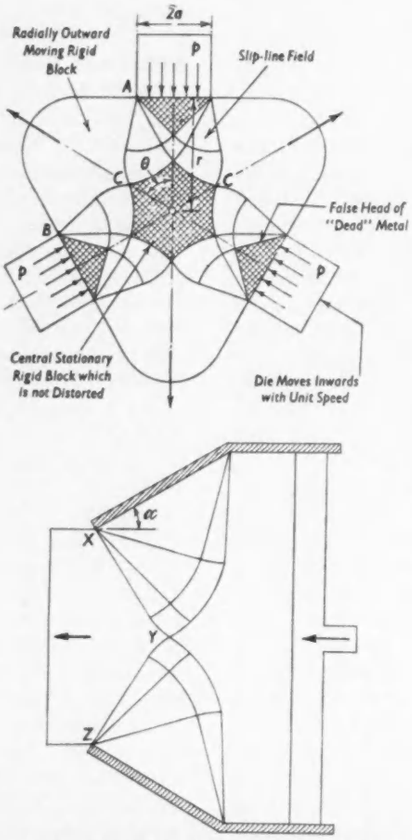


Fig. 1(*a*) (Top)—Slip-line field solution for indenting a block with three dies of equal width. Fig. 1 (*b*) (Below)—Slip-line field solution for extrusion through a smooth wedge-shaped die, for a small reduction

The uniform pressure p required on the die to cause indenting may be calculated using the Hencky equations, starting from the fact that there is zero net force over lines such as *ACB*, and is obtained in terms of k the yield shear stress of the material under conditions of plane strain. (k=0·58 Y, or 0·5 Y, Y being the yield stress of the material in simple tension, depending on whether the von Mises or the Tresca yield criterion, respectively, is adopted.)

Fig. 1 (*b*) shows the slip-line field for extrusion through a smooth wedge-shaped die of semi-angle α (30 deg. in this instance),

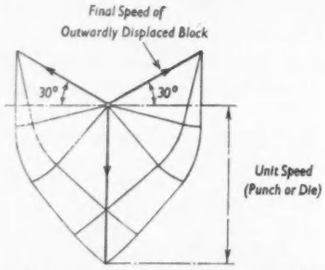


Fig. 2—Hodograph corresponding to the slip-line field for the portion above *COC* in Fig. 1(*a*); hodograph for other two portions is of similar shape

for a comparatively small reduction. Clearly no net force acts on the final rigid extruded product to the left of line *XYZ*. Now comparing Figs. 1 (*a*) and 1 (*b*), there is a formal identicality in the stress fields and it will be appreciated that the die pressure in both instances will be the same (if the geometric proportions are also the same in the two cases, of course). It may be added that if n equally oriented similarly sized dies are employed, the analogous die semi-angle α would be $(\pi/2n)$ $(n-2)$. The appropriate values of p for extruding through dies of wedge angle 30 deg. and 60 deg. in particular have been given by Hill[2] and Johnson[3]; and these authors also give values of p for other values of α between 10 deg. and 70 deg., and for other required α values, not multiples of 10 deg., $p/2k$ could be interpolated as desired.

If as the geometric variable, ratio $r/2a$, is taken, see Fig. 1 (*a*), then Fig. 3 may easily be constructed relating $p/2k$ and $r/2a$ for a particular case. Fig. 3 gives values of $p/2k$ versus $r/2a$ for indenting with two, three, four and six dies. It has to be observed, however, that $p/2k$ values in excess of about 2·57 are probably inadmissible, the material then not deforming in the manner described above by being pushed radially outwards, but by being thrown up or caused to bulge at the sides of the dies; the zones of plastic deformation do not then penetrate the whole block but are constrained to develop locally about the dies.[2] The figure of 2·57 also depends upon the material being in line with the dies to the extent of the die width on both sides of a die.

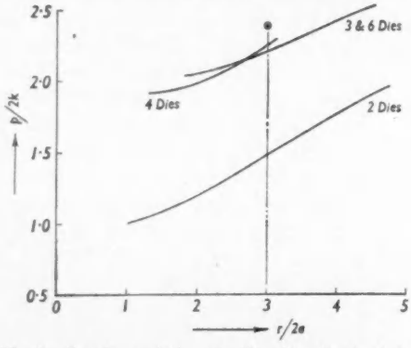


Fig. 3—Showing variation of $p/2k$ with $r/2a$ for 2, 3, 4 and 6 dies, for the situation in Fig. 1(*a*)

Supposing that the slip-line field for the problem is given (co-ordinates for a 15 deg. equiangular net are given by Hill[2]), there remains the problem of performing a numeri-

*Department of Mechanical Engineering, University of Manchester.

† An account of the theory of slip-line fields may be found in Chapter VI of R. Hill's *Mathematical Theory of Plasticity* (Clarendon Press).

cal integration for each value of $r/2a$ and it is therefore useful to examine an approximate method of estimating $p/2k$ that is comparatively simple and rapid, though providing load estimates that are somewhat larger than that given by the individual slip-line field. The method is best illustrated by a numerical

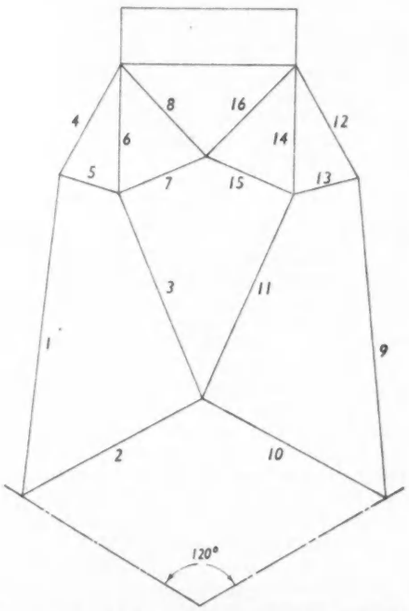


Fig. 4—A slip-line field of the type in Fig. 1 (*a*) rationalised into a system of rigid blocks. The numbered lines indicate the regions along which velocity discontinuities occur. (Diagram to scale for $r/2a=3$)

example and a value 3 for $r/2a$ is selected. The salient points in the slip-line field, obtained by consulting Hill's table, are obtained and the collection of blocks shown in Fig. 4 is drawn, it being, in effect, a rationalised slip-line field. These triangular or quadrilateral shaped blocks are considered to be rigid. When the die forces in the false nose, each other block is moved. However, contiguous blocks must remain in contact, otherwise voids would open up in the material; this is the same as saying that velocities normal to bounding lines are continuous across them. Further, there is relative movement between the blocks due to the slipping of one over the other; the relative velocity of slipping between the blocks is a velocity discontinuity across the boundary lines of an individual block and in reality such lines are of finite thickness within which shearing occurs. Corresponding to unit speed for a die, the hodograph shown in Fig. 5 can be

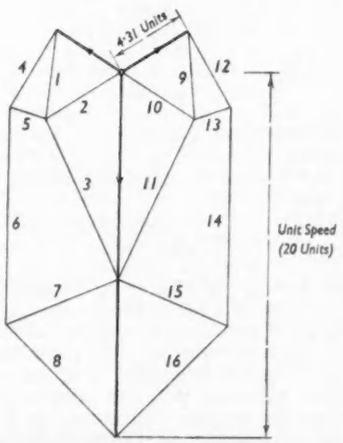


Fig. 5—Scale drawing of hodograph for Fig. 4

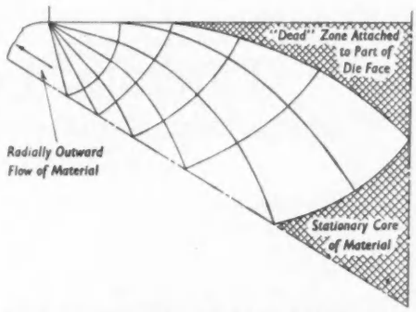


Fig. 6—A slip-line field (one-sixth of field, there being a six-fold symmetry), for a very rough indenter, when r is much less than $2a$, and the dead metal zone extends only over part of the die face

constructed; this is, in effect, a rationalisation of Fig. 2.

The indenting pressure may now be obtained using a theorem due to Hill[4] or Drucker, Greenberg and Prager,[5] which may be expressed for use in this instance as

$$p/2k=\Sigma V^*\,.\,S/2$$

V^* is the velocity discontinuity between blocks and S the corresponding line length over which it occurs; corresponding S and V^* qualities are similarly labelled in Figs. 4 and 5, which are scale diagrams. If these are extracted they will be found to be (to an arbitrary scale) thus:—

line	1	2	3	4	5	6	7	8
V^*	17·6	11·5	12·2	7·1	3·6	7·1	5·3	7·1
S	4·6	4·8	9·8	4·8	2·0	11·8	6·6	8·7

Thus, if $2a=10$ units, and ON=20 units (unit speed), then $p/2k=477/2\times5\times20=2{\cdot}38$. When compared with the slip-line field solution this latter figure is seen to be about 8 per cent in excess (Fig. 3).

The analyses presented above deal with the

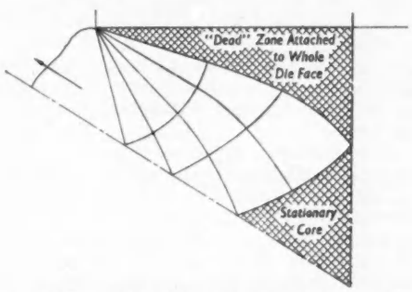


Fig. 7—A slip-line field of the same kind as that in Fig. 6, but r not much less than $2a$

case in which $r>a$; if $r<a$, and if the die is very rough, then slip-line fields of a different form are essential, and these are shown in Figs. 6 and 7. Since the fields have a six-fold symmetry, only one-sixth of the complete field is given. In Fig. 6 the case in which a is considerably larger than r is shown and involves having a dead zone adhering to the die over only a part of the die, shearing occurring near the die edges. If $r<a$ but not greatly so, the dead zone extends over the whole die face, Fig. 7. These solutions remain analogous to sheet extrusion through very rough wedge-shaped dies of large reduction and the basic data for determining pressures is available elsewhere.[6]

The analysis of indentation when the dies are not of equal width and not symmetrically situated presents little difficulty, since the slip-line fields will remain basically of the same form as those in Fig. 1. The techniques required would essentially be the same as those used in analysing multi-hole extrusions through orifices of unequal size, though obtaining such results would be a tedious task.[6]

In the solutions described, the material touches the dies over the whole of their length and the situation may be definitely described as indenting. In many cases of metal-forming the contact does not extend over the whole length of the die face and in that case a different type of field is required. Fig. 8 (*a*)

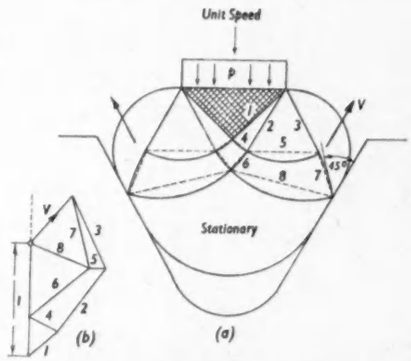


Fig. 8—(*a*) Slip-line field showing one indenter and two perfectly smooth supports. Dotted lines define the blocks of the rationalised stress field. (*b*) Hodograph of the rationalised field of Fig. 8 (*a*) for one-sixth of the whole situation

shows one indenter and support by two lower perfectly smooth faces. The material displacement directions are now different from the previous cases. A lower stationary region beneath the slip-line field is trapped and cannot move, whilst the two side regions are compelled to move parallel to the supporting faces. Fig. 8 (*b*) gives the hodograph corresponding to Fig. 8 (*a*) when it has been rationalised into rigid "blocks" defined by the straight, full and dotted lines shown.

A yet further kind of solution is obtained for a perfectly smooth die developed from Hill's solution[2] to the "compression of a wedge by a flat die," as in Fig. 9 (*a*). With certain limitations this consists of a central symmetrical stationary region with a mass material displacement parallel to lines such as "5." Again, rationalising the sector and triangle solution of Fig 9 (*a*), to three rigid triangles, the hodograph is easily obtained as in Fig. 9 (*b*).

Nasmyth and the V-Anvil

Now reverting to the theme mentioned in the opening paragraphs, it may be recalled that Nasmyth[1] introduced the V-anvil in 1845. He gave as his reason the fact that this form of block did not produce "unsound-

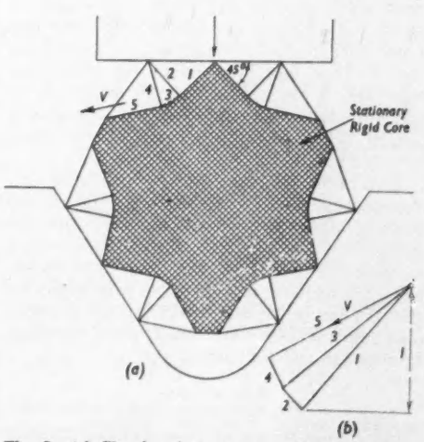


Fig. 9—(*a*) Showing instantaneous slip-line field for forging with a smooth die, consisting of circular sectors and 45 deg. isosceles triangles. (*b*) Hodograph corresponding to rationalised field of Fig. 9 (*a*) a straight line "3" being substituted for the arc

ness " at the centre of the forging. Before quoting the remarks taken from his chronological list of Inventions and Contrivances,[1] it is worth while and relevant to reproduce Hill's solution to the problem of forging with a single pair of dies; this is shown in Fig. 10 and in particular the shearing or cleaving

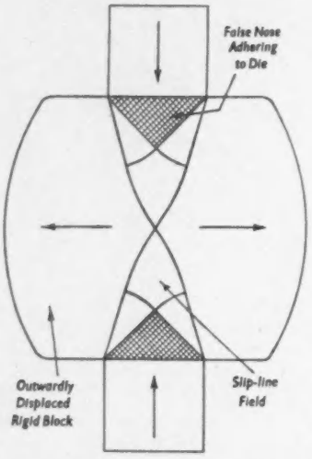


Fig. 10—Hill's slip-line field for indenting with two dies

action at the centre of the block where the slip-lines intersect will be noted.

Nasmyth wrote:—

" In connection with my Steam Hammer, when employed in forging great cylindrical shafts, I introduced what I termed my V-anvil. Its employment has most importantly contributed to secure perfect soundness in such class of forgings. In the old system of forging cylindrical shafts, the bar was placed upon a flat-faced anvil. The effect of each blow of the hammer upon the work was to knock the shaft into an oval form (see Fig. 11);

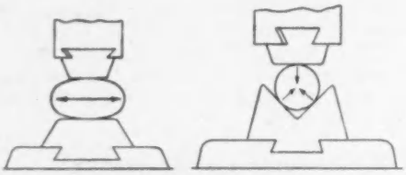


Fig. 11—(a) Reproduction of Nasmyth's sketch of a flat-anvil forging. (b) Reproduction of Nasmyth's sketch of a V-anvil forging

and the inevitable result of a succession of such blows was destruction of the soundness of the centre or axis of the shaft. In order to remedy this grave defect, arising from the employment of a flat-faced anvil, I introduced my V-anvil face, the effect of which was that the dispersive action of the blow of the hammer was changed into a converging action, which ensured the perfect soundness of the work."

Except in the case shown in Fig. 8—an " unsymmetrical " instance—the predicted form of all the stress fields and the peripheral regions over which plastic deformation occurs leaving a central rigid core of material which, it is emphasised, are dictated principally by the geometry of the situation, are seen to agree admirably with Nasmyth's practical knowledge and judgment.

REFERENCES

[1] Nasmyth, J., 1885, *Autobiography*, edited by Samuel Smiles. John Murray, London.
[2] Hill, R., 1950, *Mathematical Theory of Plasticity* (Clarendon Press).
[3] Johnson, W., 1955, *Journal Mech. and Phys. Solids*, 3, 218.
[4] Hill, R., 1951, *Phil. Mag.*, 42, 868.
[5] Drucker, D. C., Greenberg, H. J., and Prager, W., 1951, *Journal App. Mechanics, A.S.M.E.*, 18, 37.
[6] Johnson, W., Mellor, P. B., and Woo, D. M., 1957. To be published.

Laterally Loaded Plates

(MOMENT DISTRIBUTION AROUND A SMALL CIRCULAR HOLE)

By RAYMOND HICKS, M.Sc., Ph.D.

This article deals with the problem of a small circular hole in a laterally loaded or bent plate which satisfies some condition of constraint around its boundary, for example, a rivet hole in a simply supported plate under the action of a uniformly distributed lateral load. A general expression is obtained for the deflection surface of the perforated plate when the deflection surface of a similarly loaded plate with no hole is known. This expression has been used to find the moment distribution around holes in plates which are triangular, elliptical, circular and rectangular in plan.

IT has been shown by Goodier[1] that the presence of a circular hole in an unsupported bent plate results in an increase of the maximum moment. For example, the maximum moment in a perforated rectangular plate uniformly bent about one axis is about 70 per cent greater than the maximum moment in a similarly loaded plate with no hole.

Goodier also considered the effect of the relative size of the hole on the moment distribution in the plate. He found that when the ratio of the width of the plate to the diameter of the hole is large (say, >6), the change in the moment distribution due to the introduction of the hole is local and independent of the relative size of the hole.

Reissner[2] has shown that when the diameter of a hole gets less than about three times the thickness of the plate, the classical theory for bending gives values for the tangential moment around the hole which are considerably less than the true values. These errors are due to the assumption that deflections due to transverse shear are small compared with the deflections due to bending.

In all the problems considered here it is assumed that the diameter of the hole is greater than three times the thickness of the plate so that the classical theory can be used to predict the moment distribution around the hole.

For a simply supported equilateral triangular plate bent by constant moments around its boundary, it is found that the introduction of a small circular hole at its centre of area increases the maximum moment in the region of the hole by 100 per cent without increasing the maximum moment in the plate. This is due to the fact that the bending moments at the centre of area of an unperforated plate are considerably smaller than the maximum moment which occurs at its boundary.

An expression is obtained for the tangential moment around a hole which does not necessarily occur at the centre of area of the plate. This expression is used to show that a small hole near an apex of the triangle increases the maximum moment in the plate by 77·8 per cent when Poisson's ratio is 0·3.

For a simply supported equilateral triangular plate under the action of a uniformly distributed load, it is found that the effect of a hole at its centre of area results in a local moment which is 86 per cent greater than the maximum moment in a similarly loaded unperforated plate. When the hole occurs at the point where the moment in a similarly loaded unperforated plate is a maximum, the effect of the hole is to increase the maximum moment in the plate by 92·2 per cent.

In the case of a hole at the centre of a uniformly loaded built-in elliptical plate, the maximum peripheral moment is greater than the maximum moment in a similarly loaded unperforated plate when the ratio of its major and minor axes is smaller than a given critical value. Above this critical value the maximum moment in the plate occurs on its boundary at the end of the minor axis. In the limit when the plate becomes circular the effect of the hole is to induce a local moment which is 100ν per cent greater than the maximum moment in a similarly loaded unperforated plate (where ν is Poisson's ratio). An expression is obtained for the tangential moment around a hole which does not necessarily occur at the centre of area of the plate. This is used to show that a small hole near the end of the minor axis increases the maximum moment in the plate by

$$[(2+3\nu-\nu^2)/(3+\nu)]\ 100 \text{ per cent.}$$

The introduction of a non-concentric hole in a uniformly loaded simply supported circular plate results in a local moment which is greater than the maximum moment in a similarly loaded unperforated plate. This local moment increases in magnitude as the eccentricity of the hole decreases and in the limit, when the hole is concentric, reaches a value which is double the maximum moment in a similarly loaded plate with no hole.

For a simply supported rectangular plate under the action of a lateral load system, a general expression is obtained for the moment distribution around a small hole which is not necessarily at its centre of area. This expression is written in terms of a set of arbitrary constants which determine the distribution of the lateral load system acting on the plate. As an example, a particular load system is considered and it is found that in this case the effect of the hole is to increase the maximum moment by as much as 100 per cent when the plate is square.

THEORY

The deflection surface of a laterally loaded plate containing a small circular hole is given by a suitably chosen solution of the equation

$$\left[\frac{\partial^2}{\partial r^2}+\frac{1}{r}\frac{\partial}{\partial r}+\frac{1}{r^2}\frac{\partial^2}{\partial\theta^2}\right]^2 w=\frac{q}{D} \quad . \quad . \quad (1)$$

where w is the deflection of the plate at any particular point, q the intensity of the lateral loading, and r, θ polar co-ordinates chosen so that they have their origin at the centre of the hole.

D is the flexural rigidity of the plate and is given by

$$D=\frac{Eh^3}{12(1-\nu^2)}$$

where h is the thickness of the plate, E Young's modulus, and ν Poisson's ratio.

On an elemental area of the plate subtended by an angle $\delta\theta$ at the centre of the hole M_r, M_θ and $M_{r\theta}$ are the radial, tangential and twisting moments per unit length, while Q_r and Q_θ are the accompanying shear forces. There are no horizontal shearing forces and no forces normal to the sides of

the element since the strain at the middle plane of the plate is negligible when the deflections are small.

From the classical theory for bent plates, M_r, &c., can be written in terms of the deflection surface as follows :

$$M_r=-D\left[\frac{\partial^2 w}{\partial r^2}+\frac{\nu}{r}\frac{\partial w}{\partial r}+\frac{\nu}{r^2}\frac{\partial^2 w}{\partial\theta^2}\right] \quad . \quad (2)$$

$$M_\theta=-D\left[\nu\frac{\partial^2 w}{\partial r^2}+\frac{1}{r}\frac{\partial w}{\partial r}+\frac{1}{r^2}\frac{\partial^2 w}{\partial\theta^2}\right] \quad . \quad (3)$$

$$M_{r\theta}=D(1-\nu)\left[\frac{1}{r}\frac{\partial^2 w}{\partial r\partial\theta}-\frac{1}{r^2}\frac{\partial w}{\partial\theta}\right] \quad . \quad (4)$$

$$Q_r=-D\frac{\partial}{\partial r}\left[\frac{\partial^2 w}{\partial r^2}+\frac{1}{r}\frac{\partial w}{\partial r}+\frac{1}{r^2}\frac{\partial^2 w}{\partial\theta^2}\right] \quad . \quad (5)$$

$$Q_\theta=-\frac{D}{r}\frac{\partial}{\partial\theta}\left[\frac{\partial^2 w}{\partial r^2}+\frac{1}{r}\frac{\partial w}{\partial r}+\frac{1}{r^2}\frac{\partial^2 w}{\partial\theta^2}\right] \quad . \quad (6)$$

In addition to the relationships given above, there are the following two further relationships which give the resultant shear on radial and tangential boundaries of the plate.

$$V_\theta=\left[Q_\theta-\frac{\partial}{\partial r}M_{r\theta}\right] \quad . \quad . \quad . \quad . \quad (7)$$

$$V_r=\left[Q_r-\frac{1}{r}\frac{\partial}{\partial\theta}M_{r\theta}\right] \quad . \quad . \quad . \quad (8)$$

These relationships, which were first obtained by Kirchhoff,[3] imply that on a free edge of the plate the shear force Q_r (or Q_θ) and the twisting moment $M_{r\theta}$ are not necessarily zero. The physical significance of this apparent reduction in the necessary number of boundary conditions has been explained by Thomson and Tait[4] (see also reference 5, page 90).

Substituting (4) and (5) in (8), it is found that on the free edge of the plate around the hole the following boundary condition must be satisfied.

$$\left[\frac{\partial^3 w}{\partial r^3}-\frac{1}{r^2}\frac{\partial w}{\partial r}+\frac{1}{r}\frac{\partial^2 w}{\partial r^2}-\frac{(3-\nu)}{r^3}\frac{\partial^2 w}{\partial\theta^2}+\frac{(2-\nu)}{r^2}\frac{\partial^3 w}{\partial r\partial\theta^2}\right]_{r=e}=0 \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where $2e$ is the diameter of the hole.

Since there is no radial moment acting on the plate around the hole, the second boundary condition is given by

$$\left[\frac{\partial^2 w}{\partial r^2}+\frac{\nu}{r}\frac{\partial w}{\partial r}+\frac{\nu}{r^2}\frac{\partial^2 w}{\partial\theta^2}\right]_{r=e}=0 \quad . \quad . \quad (10)$$

The determination of the deflection surface of a laterally loaded plate containing a small circular hole therefore reduces to the finding of a solution of (1), which satisfies the conditions around the edges of the plate and the conditions implicit in (9) and (10).

When dealing with any particular problem, it is convenient to consider the deflection surface as being made up of the two parts

$$w=w_1+w_2 \quad . \quad . \quad . \quad . \quad (11)$$

where w_1 is the deflection surface of a similarly loaded plate with no hole, and w_2 the change in this deflection surface due to the introduction of the hole. It therefore follows that if, as it is assumed in this analysis, the deflection surface of a similarly loaded plate with no hole is known, the problem resolves itself into the finding of a complementary solution of (1), which satisfies the conditions around the edges of the plate and which, in conjunction with w_1, gives an expression for w which satisfies the boundary conditions around the hole.

Regardless of the original choice for the co-ordinate system determining the deflection surface of a similarly loaded plate with no hole, it is usually found when dealing with practical problems that in the region of the hole w_1 can be expressed in the form

$$w_1=\sum_0^\infty\sum_0^\infty C_{mn}r^m\cos n\theta+\sum_0^\infty\sum_0^\infty S_{mn}r^m\sin n\theta \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where C_{mn} and S_{mn} are known constants.

When w_1 has the form given above it can be shown by direct substitution that the complementary solution of (1) which can be made to satisfy the boundary conditions around the hole, and give a satisfactory approximation to the boundary conditions around the edges of the plate, is given by

$$w_2=C'_0\log r+D'_0r^2\log r+\sum_1^\infty\left[\frac{A'_n}{r^n}+\frac{B'_n}{r^{n-2}}\right]\cos n\theta+\sum_1^\infty\left[\frac{C'_n}{r^n}+\frac{D'_n}{r^{n-2}}\right]\sin n\theta \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where C'_0, D'_0, A'_n, &c., are constants which are determined by the boundary conditions. The solution of any particular problem is therefore obtained by substituting (12) and (13) in (9) and (10) and solving the resulting equations for the above constants by equating the coefficients of each $\cos p\theta$ and $\sin q\theta$ term to zero.

For example, suppose the intensity of the lateral load is constant or zero, in this case the general solution of (1), which gives the deflection surface of the unperforated plate, is as follows :

$$w_1=A_0r^2+B_0r^4+C_0+B_1r^3\cos\theta+D_1r^3\sin\theta+\sum_2^\infty[A_nr^n+B_nr^{n+2}]\cos n\theta+\sum_2^\infty[C_nr^n+D_nr^{n+2}]\sin n\theta \quad . \quad (14)$$

Substituting w_1+w_2 in (9) and (10) and solving the resulting equations, the following values are obtained for the unknown constants in the series for w_2.

$$C'_0=2\left(\frac{1+\nu}{1-\nu}\right)A_0e^2-\frac{4}{(1-\nu)}[(3+\nu)+4(1+\nu)\log e]e^4B_0 \quad . \quad . \quad . \quad . \quad . \quad (15)$$

$$D'_0=-8e^2B_0 \quad . \quad . \quad . \quad . \quad . \quad (16)$$

$$A'_1=-\left(\frac{3+\nu}{1-\nu}\right)e^4B_1 \quad . \quad . \quad . \quad (17)$$

$$A'_n=-\frac{(1-\nu)(n-1)}{(3+\nu)}e^{2n}A_n-\frac{[n^2(1-\nu)^2+8(1+\nu)]}{(3+\nu)(1-\nu)n}e^{2n+2}B_n \quad (n>1) \quad . \quad . \quad . \quad . \quad . \quad (18)$$

$$B'_n=\left(\frac{1-\nu}{3+\nu}\right)[ne^{n-2}A_n+(n+1)e^nB_n]e^n \quad (n>1) \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where the relationships between the constants in the sine terms are the same as the above relationships between the constants in the cosine terms.

Infinitely Small Holes

When the diameter of the hole is infinitely small compared with the lateral dimensions of the plate, some of the constants appearing in the general expression for w_2 can be taken as zero since they are associated with terms which become neligible after the necessary number of differentiations to obtain expressions for the moments and shear in the plate. The conditions determining which of these constants can be taken as zero are obtained by considering a general term in the series for w_1 and the complementary term in the series for w_2. Thus, if $C_{mn}r^m\cos n\theta$ is a general term in (12), the complementary term in (13) is

$$\left(\frac{A'_n}{r^n}+\frac{B'_n}{r^{n-2}}\right)\cos n\theta \quad . \quad . \quad . \quad (20)$$

Substituting both these terms in the boundary conditions specified by (9) and (10) and solving the resulting equations, it is found that

$$A'_n=K_n\frac{e^{m+n}}{b^{m-1}}, \qquad B'_n=K'_n\frac{e^{m+n-2}}{b^{m-1}} \quad . \quad (21)$$

where K_n and K'_n are dimensionless constants, and b a lateral dimension of the plate. These relationships satisfy the condition that w_2 has the dimensions of length.

The complementary term (20) can therefore be written in the following form.

$$\left[K_n\frac{e^{m+n}}{b^{m-1}r^n}+K'_n\frac{e^{m+n-2}}{b^{m-1}r^{n-2}}\right]\cos n\theta \quad . \quad (22)$$

If this expression is differentiated the necessary number of times in order to obtain the moments and shear in the plate, it is found that in the limit when $b/e\to\infty$ the moments are zero for all values of r when $m>2$ and the shear forces zero for all values of r when $m>3$. Similarly, by considering the dimensions of the $C'_0\log r$ and $D'_0r^2\log r$ terms in (13), it is found that in the limit when $b/e\to\infty$ the $D'_0r^2\log r$ is associated with moments and shear which are zero at all points in the plate.

With regard to the general term $C_{mn}r^m\cos n\theta$ in the expression for a similarly loaded plate with no hole, it is found from a consideration of dimensions that the constant C_{mn} can be written as follows.

$$C_{mn}=\frac{K_{mn}}{b^{m-1}},$$

where K_{mn} is a dimensionless constant and b a lateral dimension of the plate.

Substituting the term $C_{mn}r^m\cos n\theta$ in the appropriate expressions for the moments and shear forces, it is found that in the limit when $b/e\to\infty$ this term is associated with moments which are zero around the hole when $m>2$ and with shear forces which are zero around the hole when $m>3$.

The above results can be summarised as follows. (*a*) If the deflection surface of a plate with an infinitely small hole contains a term of the type $C_{mn}r^m\cos n\theta$, this term has no effect on the moment distribution around the hole when $m>2$ and no effect on the accompanying shear forces when $m>3$. Furthermore, the complementary term $(A'_nr^{-n}+B'_nr^{-n+2})\cos n\theta$ has no effect on the moment distribution in the whole plate when $m>2$ and no effect on the accompanying shear distribution when $m>3$. (*b*) If the expression for w_2 contains a term $D'_0r^2\log r$, this term can be neglected when $b/e\to\infty$ since it has no effect on the moment and shear distribution in the plate.

Substituting (13) and (14) in (3) and using the above results to determine which constants in w_1+w_2 can be taken as zero, the following expression is obtained for the tangential moment around an infinitely small circular hole in a uniformly loaded plate.

$$(M_\theta)_e=-D[2(1+\nu)A_0-2(1-\nu)A_2\cos 2\theta-2(1-\nu)C_2\sin 2\theta]-D\left[2(1+\nu)A_0-2\frac{(1-\nu)(1+3\nu)}{(3+\nu)}A_2\cos 2\theta-2\frac{(1-\nu)(1+3\nu)}{(3+\nu)}C_2\sin 2\theta\right] \quad . \quad . \quad (23)$$

The first component in this expression

gives the moment in a similarly loaded plate with no hole, and the second component gives the increase in this moment due to the introduction of the hole.

Combining the two components of the moment, the above expression becomes

$$(M_\theta)_e = -4(1+\nu)D\left[A_0 - 2\left(\frac{1-\nu}{3+\nu}\right)A_2 \cos 2\theta - 2\left(\frac{1-\nu}{3+\nu}\right)C_2 \sin 2\theta\right] \quad . \quad . \quad . \quad . \quad . \quad (24)$$

It follows from (14) that the above result gives the tangential moment around an infinitely small hole in a plate under the action of any type of loading provided w_1 can be written in the following form :

$$w_1 = A_0 r^2 + A_2 r^2 \cos 2\theta + C_2 r^2 \sin 2\theta + f(r,\theta) \quad . \quad . \quad . \quad . \quad . \quad (25)$$

where $f(r\,.\,\theta)$ represents terms which become zero around the hole after the necessary differentiation to obtain the bending moments.

Triangular Plates

As an example of the type of problem under discussion, consider the case of a small circular hole at the centre of area of a simply supported equilateral triangular plate bent by constant moments distributed around its boundary.

The deflection surface of a similarly loaded plate with no hole is the same as that of a uniformly stretched and uniformly loaded membrane, and is given by the following expression, which was first obtained by S. Woinowsky-Krieger[6] (see also reference 5, page 102).

$$w_1 = \frac{M_n}{4bD}\left[x^2 - 3xy^2 - b(x^2+y^2) + \frac{4b^2}{27}\right] . \quad (26)$$

where M_n is the moment per unit length applied to the boundary of the plate, b the length of the plate measured perpendicularly from one of its sides, and x, y cartesian co-ordinates having their origin at the centre of area of the equilateral triangle. The x axis is chosen so that it lies on a line bisecting the plate and is assumed positive in the direction of the apex of the triangle.

Making the substitutions $x = r\cos\theta$ and $y = r\sin\theta$, the above expression for the deflection surface can be written in polar co-ordinates as follows :

$$w_1 = \frac{M_n}{4bD}\left[r^2\cos 3\theta - br^2 + \frac{4b^2}{27}\right] . \quad . \quad . \quad (27)$$

In order to satisfy the boundary conditions around the hole and to obtain a satisfactory approximation to the boundary conditions around the edges of the plate, the general pattern of the above expression for w_1 indicates that the necessary form of w_2 is given by the expression

$$w_2 = \frac{M_n}{4bD}\left[C'_0 \log\frac{3r}{b} + D'_0 r^2 \log\frac{3r}{b} + \frac{A'_3}{r^3}\cos 3\theta + \frac{B'_3}{r}\cos 3\theta\right] . \quad . \quad . \quad (28)$$

where the $\log 3r/b$ term has been chosen to give zero deflections at the midpoint of each side of the plate.

Substituting $w_1 + w_2$ in (9) and (10) and solving the resulting equations, it is found that the constants in w_2 are given by

$$\left.\begin{aligned} C'_0 &= -2\left(\frac{1+\nu}{1-\nu}\right)be^2, \quad & D'_0 &= 0 \\ A'_3 &= -2\left(\frac{1-\nu}{3+\nu}\right)e^6, \quad & B'_3 &= 3\left(\frac{1-\nu}{3+\nu}\right)e^4 \end{aligned}\right\} . \quad (29)$$

Using these values for the constants, the expression for the deflection surface becomes

$$w = w_1 + w_2 = \frac{M_n}{4bD}\left[r^2\cos 3\theta - br^2 + \frac{4b^2}{27}\right] - \frac{M_n}{4bD}\left[2\left(\frac{1+\nu}{1-\nu}\right)be^2\log\frac{3r}{b} + \left(\frac{1-\nu}{3+\nu}\right)\left(\frac{2e^3}{r^3} - \frac{3e}{r}\right)e^3\cos 3\theta\right] \quad . \quad (30)$$

This expression indicates that w_2 is not zero around the edges of the plate, and therefore does not satisfy completely all the boundary conditions necessary for the exact solution of the problem.

Around the edges of the plate the actual variation of w_2 about a mean value depends upon the ratio e/b. It can be verified by considering particular numerical examples that when the diameter of the hole satisfies the condition that it is small compared with the length of the plate, the variation of w_2 around the boundary is small compared with the maximum deflection of the plate and can therefore be neglected. For example, when Poisson's ratio $= 0{\cdot}3$ and $b/e = 30$ the variation of w_2 about a mean value is less than 1 per cent of the maximum deflection of the plate.

In the limit when $b/e \to \infty$ (say, for example, a rivet hole) it can be seen that $w_2/w_1 \to \infty$, so that the introduction of the hole does not affect the deflection surface of the plate. It is shown later that this does not imply that the moment and shear distribution in the plate is the same as in a similarly loaded plate with no hole.

Substituting the above expression for w in (2) and (3), it is found that the radial and tangential bending moments in the plate are as follows :

$$M_r = \frac{M_n}{4b}[2(1+\nu)b - 6(1-\nu)r\cos 3\theta] - \frac{M_n}{4b}\left[2(1+\nu)\frac{be^2}{r^2} - 24\frac{(1-\nu)^2}{(3+\nu)}\frac{e^6}{r^5}\cos 3\theta + 6\frac{(1-\nu)(1-5\nu)}{(3+\nu)}\frac{e^4}{r^3}\cos 3\theta\right] \quad . \quad . \quad . \quad . \quad . \quad (31)$$

$$M_\theta = \frac{M_n}{4b}[2(1+\nu)b + 6(1-\nu)r\cos 3\theta] + \frac{M_n}{4b}\left[2(1+\nu)\frac{be^2}{r^2} - 24\frac{(1-\nu)^2}{(3+\nu)}\frac{e^6}{r^5}\cos 3\theta + 6\frac{(1-\nu)(5-\nu)}{(3+\nu)}\frac{e^4}{r^3}\cos 3\theta\right] \quad . \quad . \quad . \quad . \quad . \quad (32)$$

In each of these expressions the first term represents the moment in a similarly loaded plate with no hole, while the second term shows the change in the moment due to the introduction of the hole. It can be seen that when b/e is sufficiently large the terms containing e^6/r^5 and e^4/r^3 can be neglected when determining the moment distribution in the plate. Furthermore, the term containing e^2/r^2 can be neglected when r is several times greater than e, so that the effect of the hole on the moment distribution in the plate is local.

Since w_2 is associated with a moment distribution which has normal components around the edges of the plate, it follows that the error in the bending condition around the supported edges of the plate is given by the deviation in the analytical value for the normal applied moment about the true value M_n. The maximum deviation occurs at the midpoint of each side of the plate and is determined mainly by the a^2/r^2 term in (31) when $r = b/3$. Thus, the maximum deviation in the applied normal moment is given by

$$\delta M_n = \frac{9}{2}M_n(1+\nu)\frac{e^2}{b^2} \quad . \quad . \quad . \quad (33)$$

It can be verified that this deviation is negligible when the hole is small. For example, if $\nu = 0{\cdot}3$, a deviation of 1 per cent is obtained when the length of the plate is twelve times the diameter of the hole.

Putting $r = e$ in the expression for M_θ and neglecting small order terms, it is found that the effect of the hole is to increase the maximum moment at the centre of area of the plate by 100 per cent. Thus, around the hole

$$(M_\theta)_{max} = M_n(1+\nu) \quad . \quad . \quad . \quad (34)$$

The maximum moment in a similarly loaded plate with no hole occurs at the corners on a plane bisecting the plate, and is given by the expression

$$M'_{max} = \frac{M_n}{2}(3-\nu) \quad . \quad . \quad . \quad (35)$$

Since this moment occurs at a point in the plate which is virtually unaffected by the presence of the hole, it follows from (34) and (35) that for practical values of ν the hole has no effect on the maximum moment in the plate.

Substituting the appropriate expression for w in (4), it is found that the twisting moment in the plate is given by

$$M_{r\theta} = -(1-\nu)M_n\frac{3r}{2b}\left[1 + 4\left(\frac{1-\nu}{3+\nu}\right)\frac{e^6}{r^6} - 3\left(\frac{1-\nu}{3+\nu}\right)\frac{e^4}{r^4}\right]\sin 3\theta \quad . \quad (36)$$

The first term represents the twisting moment in a similarly loaded unperforated plate, while the second and third terms represent the change in the twisting moment due to the introduction of the hole. It can be seen that the last two terms are comparable with the first term only in the region near the hole where the twisting moment is relatively small.

Finally, from (5), (6) and (28) it is found that the shear distribution in the plate with a hole is given by the following expressions:—

$$Q_r = -18\frac{M_n}{b}\left(\frac{1-\nu}{3+\nu}\right)\frac{e^4}{r^4}\cos 3\theta \quad . \quad (37)$$

$$Q_\theta = -18\frac{M_n}{b}\left(\frac{1-\nu}{3+\nu}\right)\frac{e^4}{r^4}\sin 3\theta \quad . \quad . \quad (38)$$

These shear forces are due entirely to the presence of the hole and can be shown to be associated with stresses which are small compared with the accompanying bending stresses.

In the particular problem considered above, it was found that the introduction of a small circular hole at the centre of area of the plate increased the maximum moment in the region of the hole by 100 per cent without resulting in an increase in the maximum moment in the plate. When the maximum moment in a plate with no hole is sufficiently close to the region where it is proposed to introduce the hole, the effect of the hole will be to introduce a local moment concentration which is considerably greater than the maximum moment in a similarly loaded plate with no hole.

As an example, consider the problem of a small circular hole at the centre of area of a simply supported equilateral triangular plate bent by a uniformly distributed lateral load. The deflection surface of a similarly loaded unperforated plate is given by the following expression, which was first obtained by S. Woinowsky-Krieger[6] (see also reference 5, page 293).

$$w_1 = \frac{q}{64bD}\left[x^2 - 3xy^2 - b(x^2+y^2) + \frac{4b^2}{27}\right]\left[\frac{4}{9}b^2 - x^2 - y^2\right] \quad . \quad . \quad . \quad (39)$$

where q is the intensity of the lateral loading.

Making the substitution $x=r\cos\theta$ and $y=r\sin\theta$, the above expression for w_1 can be rewritten in the following form :—

$$w_1=\frac{4}{9}b^2K\left[r^3\cos 3\theta-br^2+\frac{4}{27}b^3\right]-K\left[r^5\cos 3\theta-br^4+\frac{4}{27}b^3r^2\right] \quad . \ . \ . \ . \ . \quad (40)$$

where $K=q/64bD$.

The required complementary solution of (1), which, in conjunction with the above expression for w_1, can be used to satisfy the boundary condition around the hole and give a satisfactory approximation to the boundary conditions around the edges of the plate, is given by the following expression :—

$$w_2=K\left[C'_0\log\frac{3r}{b}+D'_0r^2\log\frac{3r}{b}+\frac{A'_3}{r^3}\cos 3\theta+\frac{B'_3}{r}\cos 3\theta\right] \quad . \ . \ . \ . \ . \quad (41)$$

where the log $3r/b$ terms have been chosen so that they become zero at the mid-point of each side of the plate.

Substituting w_1+w_2 in (9) and (10) and solving the resulting equations, it is found that the constants in the above expression for w_2 are as follows :—

$$C'_0=-\frac{32}{27}\left(\frac{1+\nu}{1-\nu}\right)b^3e^2+4\left(\frac{3+\nu}{1-\nu}\right)be^4-\frac{8}{(1-\nu)}\left[2(1+\nu)\log\frac{3e}{b}+(3+\nu)\right]be^4 \quad . \ . \ . \ . \ . \quad (42)$$

$$D'_0=-8be^2 \quad . \ . \ . \ . \quad (43)$$

$$A'_3=-\frac{[8(1-\nu)^2(b^2-3e^2)-3(3+\nu)^2e^2]e^6}{9(1-\nu)(3+\nu)} \quad . \ . \ . \ . \ . \quad (44)$$

$$B'_3=\frac{4(b^2-3e^2)(1-\nu)e^4}{3(3+\nu)} \quad . \ . \quad (45)$$

The first term in the above expression for C'_0 is associated with the r^2 terms in (40) while the second term is associated with the accompanying r^4 term. The third term is proportional to the $D'_0r^2\log 3r/b$ term in the expression for w_2. Since the diameter of the hole is small compared with the length of the plate, it follows that the second and third terms in the expression for C'_0 can be neglected. Furthermore, it can be verified that the terms containing D'_0, A'_3 and B'_3 in w_2 have a negligible effect on the moment distribution in the plate, since they give rise to moments which are small compared with the moments derived from the $C'_0\log 3r/b$ term. It therefore follows that in order to find the change in the moment distribution due to the introduction of the hole, one need only consider an expression for w_2 which, in conjunction with the r^2 terms in w_1, satisfies the boundary conditions around the hole.

Thus, substituting the appropriate value for C_0 in (41), the deflection surface of a plate containing a small circular hole at its centre of area is given by

$$w=w_1+w_2=\frac{4}{9}Kb^2\left[r^3\cos 3\theta-br^2+\frac{4}{27}b^3\right]-K\left[r^5\cos 3\theta-br^4+\frac{4}{27}b^3r^2\right]-\frac{32}{27}K\left(\frac{1+\nu}{1-\nu}\right)b^3e^2\log\frac{3r}{b} \quad . \ . \ . \quad (46)$$

Substituting (46) in (2) and (3), it is found that the radial and tangential moments in the plate are as follows:

$$M_r=-\frac{4}{9}DKb^2[6(1-\nu)r\cos 3\theta-2(1+\nu)b]+DK\left[4(5-\nu)r^3\cos 3\theta-4(3+\nu)br^2+\frac{8}{27}(1+\nu)b^3\right]-\frac{32}{27}(1+\nu)Kb^3D\frac{e^2}{r^2} \quad . \ . \ . \quad (47)$$

$$M_\theta=\frac{4}{9}DKb^2[6(1-\nu)r\cos 3\theta+2(1+\nu)b]-DK\left[4(1-5\nu)r^3\cos 3\theta+4(1+3\nu)br^2-\frac{8}{27}(1+\nu)b^3\right]+\frac{32}{27}(1+\nu)DKb^3\frac{e^2}{r^2} \quad . \ . \ . \ . \ . \quad (48)$$

The first two terms in each of these expressions give the corresponding moment in a similarly loaded plate with no hole, while the third term represents the change in the moment due to the introduction of the hole.

From (48) it is found that when $\nu=0\cdot3$, the maximum moment around the hole is given by

$$M_{max}=0\cdot0482b^2q \quad . \ . \ . \quad (49)$$

where $q/64bD$ has been substituted for K.

The maximum moment in a similarly loaded plate with no hole occurs at the point $x=0\cdot129b$ on the line bisecting the triangle and has the following value :

$$M'_{max}=0\cdot0259b^2q \quad . \ . \ . \quad (50)$$

It therefore follows that the effect of the hole is to introduce a local moment which is 86 per cent greater than the maximum moment in a similarly loaded plate with no hole.

The solutions of the problems considered above show that when e/r becomes sufficiently small the effect of the hole on the moment and shear distributions in the plate becomes negligible. By considering the complete expression for w_2 given by (13) and the appropriate expressions for C'_0, D'_0, &c., it can be concluded that this result is true generally. It therefore follows that the solution for an infinitely small hole can be used to determine the moment and shear distribution in a plate containing a hole of finite size provided the terms containing (e/r) become sufficiently small at the boundary of the plate.

The above result greatly facilitates the evaluation of the moment distribution around a hole of finite size, as shown in the following example.

Suppose a uniformly loaded triangular plate contains a small circular hole at some point away from its centre of area. Substituting $x=x_1+c$ and $y=y_1+d$ in (39), the deflection surface of the unperforated plate can be rewritten in the following form :

$$w_1=K\left[\frac{4}{9}b^2(x_1+c)^3-(x_1+c)^5+\ldots-\frac{4}{27}(y_1+d)^2b^3\right] . \quad (51)$$

where c and d are constants which determine the position of the hole, while x_1 and y_1 are co-ordinates measured from its centre.

Writing $x_1=r\cos\theta$ and $y_1=r\sin\theta$, the above expression for w_1 becomes

$$w_1=4Kr^2\left[b(c^2+d^2)-\frac{4}{27}b^3-c^3+3d^2c\right]+2Kr^2\left[\frac{2}{3}b^2c-3c^3+b(c^2-d^2)-3d^2c\right]\cos 2\theta+2Kr^2d\left[3(d^2+c^2)+2cb-\frac{2}{3}b^2\right]\sin 2\theta+\sum_{n=1,3,4,5}(A_nr^n+B_nr^{n+2})\cos n\theta+\sum_{n=1,3,4,5}(C_nr^n+D_nr^{n+2})\sin n\theta \quad . \ . \ . \ . \ . \quad (52)$$

There is no need to evaluate the coefficients in the last two terms since they have no effect on the moment distribution around the hole. This follows from point (a) of the theory for an infinitely small hole and the fact that the $A_1r\cos\theta$ and $C_1r\sin\theta$ terms become zero after the necessary number of differentiations to obtain the bending and twisting moments in the plate.

The coefficient of the r^2 term in the above expression for w_1 corresponds to the constant A_0 in (23). Similarly, the coefficients of the $r^2\cos 2\theta$ and $r^2\sin 2\theta$ terms correspond to the constants A_2 and C_2 in (23). It therefore follows that the tangential moment distribution around the hole is given by

$$(M_\theta)_e=-16(1+\nu)KD\left\{\left[b(c^2+d^2)-\frac{4}{27}b^3-c^3+3cd^2\right]-\left(\frac{1-\nu}{3+\nu}\right)\left[\frac{2}{3}b^3c-3c^3+b(c^2-d^2)-3d^2c\right]\cos 2\theta-\left(\frac{1-\nu}{3+\nu}\right)d\left[3(c^2+d^2)+2cb-\frac{2}{3}b^2\right]\sin 2\theta\right\} \quad . \ . \ . \ . \ . \quad (53)$$

If $d=0$ and $c=0\cdot129b$ the centre of the hole coincides with the point where the moment in an unperforated plate is a maximum. Assuming $\nu=0\cdot3$, it can be verified that the effect of a hole at this point is to increase the maximum moment in the plate by 92·2 per cent.

For a uniformly bent triangular plate with a hole not at its centre of area, the deflection surface given by (26) becomes

$$w_1=\frac{M_n}{4bD}[3cr^2\cos 2\theta-3dr^2\sin 2\theta-br^2]+f(r\ .\ \theta) \quad . \ . \ . \ . \ . \quad (54)$$

where $f(r\theta)$ represents terms which do not affect the tangential moment around the hole.

The constant coefficients in the above expression for w give the coefficients A_0, A_2 and C_2 in (24). The moment distribution around the hole is therefore given by

$$(M_\theta)_e=(1+\nu)M_n\left[1+6\left(\frac{1-\nu}{3+\nu}\right)\frac{c}{b}\cos 2\theta-6\left(\frac{1-\nu}{3+\nu}\right)\frac{d}{b}\sin 2\theta\right] \quad . \ . \ . \ . \ . \quad (55)$$

When $d=0$ and $c\to 2b/3$, the centre of the hole approaches the apex of the triangle where the moment in an unperforated plate is a maximum. In this case the increase in the maximum moment due to the introduction of the hole is given by

$$\text{Increase}=\frac{[2(1-\nu)(1+3\nu)+(1+\nu)(3+\nu)]}{(3+\nu)(3-\nu)}\ 100\ \text{per cent} \quad . \ . \ . \ . \ . \quad (56)$$

It can be verified that when $\nu=0\cdot3$, the increase in the maximum moment is 77·8 per cent.

Elliptical Plates

The deflection surface of a uniformly loaded unperforated elliptical plate with a clamped edge is given by the following expression, which was first obtained by G. H. Bryan[7] :

$$w_1=w_0\left(1-\frac{x^2}{a^2}-\frac{y^2}{b^2}\right)^2 \quad . \ . \ . \quad (57)$$

where a is the semi-major axis of the ellipse

measured along the x co-ordinate axis, and b the semi-minor axis of the ellipse measured along the y co-ordinate axis. The constant w_0 represents the maximum deflection of the plate, and is given by

$$w_0=\frac{q}{8D\left[\frac{3}{a^4}+\frac{2}{a^2b^2}+\frac{3}{b^4}\right]} \quad . \quad . \quad . \quad (58)$$

Substituting $x=c+r\cos\theta$ and $y=d+r\sin\theta$ in (57), the deflection surface of the unperforated plate can be written in terms of polar co-ordinates measured from the centre of the hole and a line parallel to the major axis of the ellipse. The constant coefficients in this expression for w_1 correspond to the coefficients A_0, A_2 and C_2 in (23). Substituting these coefficients in (23), it is found that the moment distribution around the hole is given by

$$(M_\theta)_e=4(1+\nu)DW_0\left[\left(\frac{1}{a^2}+\frac{1}{b^2}\right)-3\left(\frac{c^2}{a^4}+\frac{d^2}{b^4}\right)-\frac{1}{a^2b^2}(d^2+c^2)\right]$$
$$-8(1+\nu)\left(\frac{1-\nu}{3+\nu}\right)DW_0\left[\left(\frac{1}{a^2}-\frac{1}{b^2}\right)-3\left(\frac{c^2}{a^4}-\frac{d^2}{b^4}\right)-\frac{1}{a^2b^2}(d^2-c^2)\right]\cos 2\theta$$
$$+32(1-\nu)\left(\frac{1+\nu}{3+\nu}\right)W_0D\frac{cd}{a^2b^2}\sin 2\theta \quad . \quad . \quad . \quad (59)$$

where c and d give the x and y co-ordinates of the centre of the hole measured from the centre of the area of the plate.

The maximum moment in a similarly loaded plate with no hole occurs at the end of the minor axis and is given by

$$M'_{max}=\frac{8W_0D}{b^2} \quad . \quad . \quad . \quad . \quad (60)$$

Putting $c=0$ in (59), it is found that the introduction of an infinitely small circular hole near the end of the minor axis increases the maximum moment in the plate by

$$\frac{(2+3\nu-\nu^2)}{(3+\nu)}\ 100 \text{ per cent} \quad . \quad . \quad (61)$$

When $\nu=0{\cdot}3$, this gives an increase of 87·75 per cent.

For a hole at the centre of the plate, the tangential moment distribution is given by

$$(M_\theta)_e=4(1+\nu)DW_0\left[\left(\frac{1}{a^2}+\frac{1}{b^2}\right)-2\left(\frac{1-\nu}{3+\nu}\right)\left(\frac{1}{a^2}-\frac{1}{b^2}\right)\cos 2\theta\right]$$
$$. \quad . \quad . \quad . \quad . \quad (62)$$

From (60) and (62) it is found that the hole does not increase the maximum moment in the plate when

$$\frac{a}{b}>\frac{\sqrt{(1+\nu)(1+3\nu)}}{(1-\nu)} \quad . \quad . \quad 63)$$

If a/b is less than the value given above, the maximum moment around the hole is greater than the maximum moment in a similarly loaded plate with no hole. Furthermore, as b/a increases above the value given in (63), the effect of the hole on the maximum moment in the plate increases until it reaches a limit when $a/b=1$. At this point, the effect of the hole is to increase the maximum moment by 100ν per cent.

For a clamped unperforated elliptical plate bent by a uniformly varying pressure $q=q_0x$, it can be shown that the deflection surface is given by (reference 4, page 292)

$$w_1=w_0x\left[1-\frac{x^2}{a^2}-\frac{y^2}{b^2}\right]^2 \quad . \quad . \quad (64)$$

where

$$w_0=\frac{q_0}{24D\left[\frac{5}{a^4}+\frac{1}{b^4}+\frac{2}{a^2b^2}\right]} \quad . \quad . \quad (65)$$

Transferring the origin of the co-ordinates to the centre of the hole and expanding w_1 as a power series, the constants A_0, A_2 and C_2 in (24) can be determined. It can then be verified that the tangential moment around a small circular hole is given by the expression

$$(M_\theta)_e=4(1+\nu)DW_0\left[\frac{c}{a^2}\left(3+5\frac{c^2}{a^2}+3\frac{d^2}{b^2}\right)+\frac{c}{b^2}\left(1+\frac{c^2}{a^2}+3\frac{d^2}{b^2}\right)\right]$$
$$-8\left(\frac{1-\nu^2}{3+\nu}\right)DW_0\left[\frac{c}{a^2}\left(3+5\frac{c^2}{a^2}+3\frac{d^2}{b^2}\right)-\frac{c}{b^2}\left(1+\frac{c^2}{a^2}+3\frac{d^2}{b^2}\right)\right]\cos 2\theta$$
$$-16\left(\frac{1-\nu^2}{3+\nu}\right)DW_0\frac{d}{b^2}\left[1+3\frac{c^2}{a^2}+\frac{d^2}{b^2}\right]\sin 2\theta$$
$$. \quad . \quad . \quad . \quad . \quad (66)$$

where c and d are the x and y co-ordinates of the centre of the hole.

Circular Plates

The deflection surface of a uniformly loaded simply supported unperforated circular plate is given by the following expression (reference 5, page 82) :

$$w_1=\frac{q}{64D}(a^2-r_1^2)\left[\left(\frac{5+\nu}{1+\nu}\right)a^2-r_1^2\right] \quad . \quad (67)$$

where $2a$ is the diameter of the hole and r_1 the radial co-ordinate measured from the centre of the plate.

If c is the eccentricity of the hole, the above expression for w_1 can be written

$$w_1=\frac{q}{64D}[a^2-r^2+2rc\cos\theta-c^2]\left[\left(\frac{5+\nu}{1+\nu}\right)a^2-r^2+2rc\cos\theta-c^2\right]$$
$$. \quad . \quad . \quad . \quad . \quad (68)$$

where r, θ are polar co-ordinates measured from the centre of the hole.

The above expression for w_1 can be expanded to give

$$w_1=-\frac{qr^2}{32D}\left[\left(\frac{3+\nu}{1+\nu}\right)a^2-2c^2\right]+\frac{qr^2c^2}{32D}\cos 2\theta+f(r\,.\,\theta) \quad . \quad (69)$$

where $f(r\theta)$ includes the terms which do not affect the moment distribution around the hole.

The constant A_0 in (24) is given by the coefficient of r^2 in w_1, while the constant A_2 in (24) is given by the coefficient of the $r^2\cos 2\theta$ term in w_1. The tangential moment distribution around the hole is therefore given by

$$(M_\theta)_e=\frac{q}{8}(1+\nu)\left[\left(\frac{3+\nu}{1+\nu}\right)a^2-2c^2+2c^2\left(\frac{1-\nu}{3+\nu}\right)\cos 2\theta\right] \quad . \quad (70)$$

The maximum moment in a similarly loaded plate with no hole occurs at its centre and has the following value:

$$M'_{max}=\frac{q}{16}(3+\nu)a^2 \quad . \quad . \quad . \quad (71)$$

From (70) and (71) it is found that the increase in the maximum moment due to the introduction of the hole can be expressed as follows :

$$\text{Increase}=\left[1-8\frac{(1+\nu)^2}{(3+\nu)^2}\frac{c^2}{a^2}\right]\ 100 \text{ per cent}$$
$$. \quad . \quad . \quad . \quad . \quad (72)$$

This is a maximum when the centre of the hole occurs at the centre of the plate. In this case the introduction of the hole increases the maximum moment in the plate by 100 per cent.

The moment distribution around a small hole in a uniformly loaded plate with clamped edges can be obtained directly from the corresponding solution for an elliptical plate. Thus, putting $d=0$ in (59), the tangential moment for a circular plate becomes

$$(M_\theta)_e=(1+\nu)\frac{a^2}{8}q\left[1-2\frac{c^2}{a^2}+2\left(\frac{1-\nu}{3+\nu}\right)\frac{c^2}{a^2}\cos 2\theta\right]$$
$$. \quad . \quad . \quad . \quad . \quad (73)$$

For a similar plate under the action of a uniformly varying pressure, the tangential moment distribution can be obtained by putting $a=b$ in (66).

Rectangular Plates

It has been shown by Navier[8] that the deflection surface of a simply supported unperforated rectangular plate can be expressed in the form of a double Fourier series provided the distribution of the lateral load can be represented by a similar series.

Thus, if the distribution of the lateral load is given by

$$q=f(x\,.\,y) \quad . \quad . \quad . \quad . \quad (74)$$

the function $f(x\,.\,y)$ can be written as

$$f(x\,.\,y)=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}A'_{mn}\sin\frac{m\pi x}{a}\sin\frac{n\pi y}{b} \quad . \quad (75)$$

where a and b are the lateral dimensions of the plate and A'_{mn} a constant given by reference 5, (page 118)

$$A'_{mn}=\frac{4}{ab}\int_0^a\int_0^b f(x\,.\,y)\sin\frac{m\pi x}{a}\sin\frac{n\pi y}{b}dxdy$$
$$. \quad . \quad . \quad . \quad . \quad (76)$$

For a rectangular plate having small deflections, w_1 is given by a suitably chosen solution of the equation

$$\left[\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right]^2 w_1=\frac{q}{D} \quad . \quad . \quad (77)$$

Substituting (75) in (77) and solving the resulting equation, it is found that the deflection surface of the unperforated plate is given by

$$w_1=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}A_{mn}\sin\frac{m\pi x}{a}\sin\frac{n\pi y}{b} \quad . \quad . \quad (78)$$

where

$$A_{mn}=\frac{A'_{mn}}{\pi^4D\left[\frac{m^2}{a^2}+\frac{n^2}{b^2}\right]^2} \quad . \quad . \quad (79)$$

Transferring the origin of the co-ordinates to the centre of the hole, the above expression for w_1 becomes

$$w_1=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}A_{mn}\sin\frac{m\pi}{a}(x_1+c)\sin\frac{n\pi}{b}(y_1+d)$$
$$. \quad . \quad . \quad . \quad . \quad (80)$$

where c and d are the x and y co-ordinates of the centre of the hole.

Expanding (80), w_1 becomes

$$w_1=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}A_{mn}\left[\sin\frac{m\pi x}{a}\sin\frac{n\pi y}{b}\cos\frac{m\pi c}{a}\cos\frac{n\pi d}{b}+\sin\frac{m\pi x}{a}\cos\frac{n\pi y}{b}\cos\frac{m\pi c}{a}\sin\frac{n\pi d}{b}+\cos\frac{m\pi x}{a}\sin\frac{n\pi y}{b}\sin\frac{m\pi c}{a}\cos\frac{n\pi d}{b}+\cos\frac{m\pi x}{a}\cos\frac{n\pi y}{b}\sin\frac{m\pi c}{a}\sin\frac{n\pi d}{b}\right]$$
$$. \quad . \quad . \quad . \quad . \quad (81)$$

This can be written in the form

$$w_1=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}A_{mn}\Big[-\frac{\pi^2}{4}\Big(\frac{m^2}{a^2}+\frac{n^2}{b^2}\Big)r^2\sin\frac{m\pi c}{a}\sin\frac{n\pi d}{b}$$
$$-\frac{\pi^2}{4}\Big(\frac{m^2}{a^2}-\frac{n^2}{b^2}\Big)r^2\sin\frac{m\pi c}{a}\sin\frac{n\pi d}{b}\cos 2\theta$$
$$+\frac{\pi^2}{4}\frac{mn}{ab}r^2\cos\frac{m\pi c}{a}\cos\frac{n\pi d}{b}\sin 2\theta+f(r\theta)\Big]$$
. . . . . (82)

where $f(r.\theta)$ contains terms which do not affect the tangential moment around the hole.

From (24), (25) and (82) the following expression is obtained for the moment distribution around the hole.

$$(M_\theta)_e=(1+\nu)D\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}A_{mn}\Big[\pi^2\Big(\frac{m^2}{a^2}+\frac{n^2}{b^2}\Big)\sin\frac{m\pi c}{a}\sin\frac{n\pi d}{b}$$
$$-2\pi^2\Big(\frac{1-\nu}{3+\nu}\Big)\Big(\frac{m^2}{a^2}-\frac{n^2}{b^2}\Big)\sin\frac{m\pi c}{a}\sin\frac{n\pi d}{b}\cos 2\theta$$
$$+4\pi^2\Big(\frac{1-\nu}{3+\nu}\Big)\frac{mn}{ab}\cos\frac{m\pi c}{a}\cos\frac{n\pi d}{b}\sin 2\theta\Big]$$
. . . . . (83)

Suppose the load distribution over the surface of the plate is given by the expression

$$q=q_0\sin\frac{\pi x}{a}\sin\frac{\pi y}{b} \quad . . . . (84)$$

in which q_0 is the intensity of the load at the centre of the plate. The deflection surface of the unperforated plate is given by

$$w_1=A_{11}\sin\frac{\pi x}{a}\sin\frac{\pi y}{b} \quad . . . (85)$$

where

$$\pi^4 D\Big(\frac{1}{a^2}+\frac{1}{b^2}\Big)^2A_{11}=q_0 \quad . . . (86)$$

If the hole occurs at the centre of the plate the tangential moment becomes

$$(M_\theta)_e=(1+\nu)\pi^2DA_{11}\Big[\Big(\frac{1}{a^2}+\frac{1}{b^2}\Big)-2\Big(\frac{1-\nu}{3+\nu}\Big)\Big(\frac{1}{a^2}-\frac{1}{b^2}\Big)\cos 2\theta\Big]$$
. . . . . (87)

This is maximum when $\theta=0$ and has the value

$$(M_\theta)_{max}=\Big(\frac{1+\nu}{3+\nu}\Big)\pi^2DA_{11}\Big[\frac{(1+3\nu)}{a^2}+\frac{(5-\nu)}{b^2}\Big]$$
. . . . . (88)

The maximum moment in a similarly loaded unperforated plate is given by (reference 5, page 114)

$$M'_{max}=\pi^2DA_{11}\Big(\frac{\nu}{a^2}+\frac{1}{b^2}\Big) \quad . . (89)$$

This moment occurs at the centre of the plate and acts in a tangential direction at the point $\theta=0$.

From (88) and (89)

$$\frac{(M_\theta)_{max}}{(M')_{max}}=\Big(\frac{1+\nu}{3+\nu}\Big)\frac{[(1+3\nu)+(5-\nu)\lambda]}{(\nu+\lambda)} \quad . (90)$$

where $\lambda=(a/b)^2$.

This expression is a maximum when the plate is square. In this case the introduction of the hole increases the maximum moment by 100 per cent. The minimum value of (90) occurs when the plate is infinitely long, and in this case the introduction of the hole increases the maximum moment by

$$[(1+\nu)(5-\nu)/(3+\nu)]\ 100 \text{ per cent.}$$

For a hole at the centre of a uniformly loaded square plate the cos 2θ and sin 2θ terms in (83) are zero, and it is again found that the effect of the hole is to increase the maximum moment in the plate by 100 per cent.

For an unperforated rectangular plate having two sides simply supported, the deflection surface w_1 is given by the series

$$w_1=\sum_{m=1}^{\infty}\Big[E_m+A_m\cosh\frac{m\pi y}{a}+B_m\frac{m\pi y}{a}\sinh\frac{m\pi y}{a}$$
$$+C_m\sinh\frac{m\pi y}{a}+D_m\frac{m\pi y}{a}\cosh\frac{m\pi y}{a}\Big]\sin\frac{m\pi x}{a}$$
. . . . . (91)

Transferring the origin of the co-ordinates to the centre of the hole and expanding each term as a product of trigonometric and hyperbolic functions, w_1 can be rewritten in a form similar to (81). Each term in this new expression for w_1 can be written as the product of two power series which when expanded reduces to the form

$$w_1=A_0r^2+A_2r^2\cos 2\theta+C_2r^2\sin 2\theta+f(r.\theta)$$
. . . . . (92)

Substituting the coefficients of (92) in (24), the tangential moment around the hole becomes

$$(M_\theta)_e=(1+\nu)\frac{\pi^2}{a^2}D\sum m^2\Big[E_m-2D_m\sinh\frac{m\pi d}{a}-2B_m\cosh\frac{m\pi d}{a}\Big]\sin\frac{m\pi c}{a}$$
$$-2\Big(\frac{1-\nu^2}{3+\nu}\Big)\frac{\pi^2}{a^2}D\sum m^2\Big[E_m+2\Big(A_m+\frac{m\pi d}{a}D_m+B_m\Big)\cosh\frac{m\pi d}{a}$$
$$+2\Big(C_m+D_m+\frac{m\pi d}{a}B_m\Big)\sinh\frac{m\pi d}{a}\Big]\sin\frac{m\pi c}{a}\cos 2\theta$$
$$+4\Big(\frac{1-\nu^2}{3+\nu}\Big)\frac{\pi^2}{a^2}D\sum m^2\Big[\Big(A_m+\frac{m\pi d}{a}D_m+B_m\Big)\sinh\frac{m\pi d}{a}$$
$$+\Big(C_m+D_m+\frac{m\pi d}{a}B_m\Big)\cosh\frac{m\pi d}{a}\Big]\cos\frac{m\pi c}{a}\sin 2\theta$$
. . . . . (93)

For a plate symmetrically loaded about the x axis the constants C_m and D_m are zero regardless of the position of the hole. When the centre of the hole occurs at any point along the x axis, the terms containing $\sinh . m\pi d/a$ are zero regardless of the distribution of the lateral loading.

REFERENCES.

[1] J. N. Goodier, *Philosophical Magazine*, Series 7, Vol. 22, 1936, pages 69–80.
[2] E. Reissner, *Journal of Applied Mechanics, Trans. A.S.M.E.*, Vol. 67, 1945, page A-69.
[3] G. Kirchhoff, *J. Crelle*, Vol. 40, 1850, page 51.
[4] Thomson and Tait, *Natural Philosophy*, Vol. 1, Part 2, 1883, page 188.
[5] S. Timoshenko, *Theory of Plates and Shells*, McGraw-Hill Book Company, Inc., 1940.
[6] S. Woinowsky-Krieger, *Ingenieur-Archiv*, Vol. 4, 1933, page 254.
[7] G. H. Bryan. See Ref. 5, page 290.
[8] Navier, *Bull. Soc. Phil.-Math.*, Paris, 1823.

MACHINING TIME CALCULATOR.—A calculator of the circular slide rule type, for calculating machining times, has been introduced by Fearns, Mear and Co., 43, St. Helens Road, Huddersfield. It is stated that it can quickly and accurately determine machining times for turned components of all kinds. Actual times required (including all normal allowances), are read off directly after the setting of a few scales. Cutting time is read off on one side of the calculator, and other dials and scales give the time increments for loading, manipulation, gauging, &c., taking into account the necessary allowances. Setting up times are provided in a separate section. The instrument is suitable for turned components between ¼in diameter and 80in diameter and lengths between ¼in and 200in.

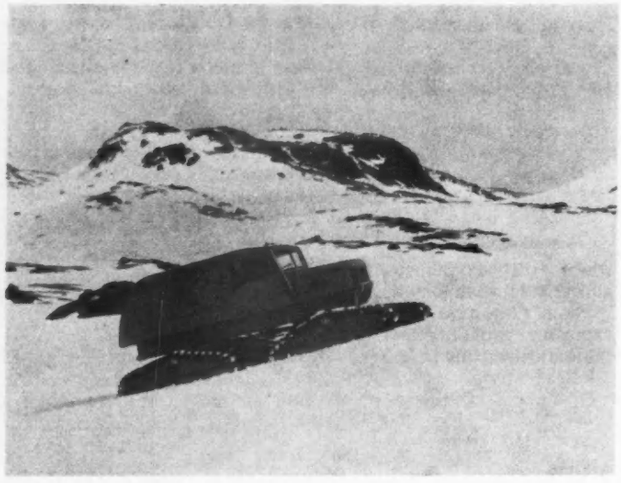
Thomas Hornbuckle—An Appreciation

By the death on February 1 of Mr. Thomas Hornbuckle there passed away a well-known railway engineer and a man greatly esteemed by his many friends. Born during 1880 at the village of Barkestone-le-Vale, Leicestershire, the son of a farmer, Hornbuckle served his apprenticeship (1897–1901) at the Grantham Works of Richard Hornsby and Sons, then engaged in the development of the Hornsby-Akroyd oil engine. While an apprentice he attended evening classes at the Technical Institute, Grantham, gaining a scholarship which secured for him an engineering course at University College, Nottingham. During the long vacation he worked in the drawing office at Hornsby's, and in the final examinations at University College he was placed first. It had been Hornbuckle's intention to find employment in the then rapidly developing electricity supply industry and he was about to accept an appointment in London, when, on the recommendation of Professor William Robinson, of Nottingham, he was offered, and thereafter accepted, a position at the Derby Works of the Midland Railway. From 1903 until 1911 he worked in the Electrical and General Engineering Section of the Locomotive Department, Derby, participating—among other activities—in investigations relating to the possibilities of single-phase electrification on the main lines of the Midland Railway. In this connection he toured the Continent inspecting electric railway operation and equipment and spending some time at the Berlin Works of Siemens Schuckert.

From 1911 until 1923 Hornbuckle was engaged in a variety of traffic operating tasks including the working out, under the late C. W. Paget, of improved methods of diagramming trains. In 1923, after the formation of the London Midland and Scottish Railway, he was transferred from the Locomotive Department and appointed Technical Assistant to the Carriage and Wagon Superintendent until, on the amalgamation of the Locomotive and Carriage Departments in 1931, he was appointed Chief Technical Assistant to the Chief Mechanical Engineer. It was at this juncture that Hornbuckle, placed in charge of experimental work on the development of diesel traction, was able to utilise the knowledge of heavy-oil engines which he had acquired long previously at Hornsby's and under Professor Robinson at University College Nottingham. His last task on the railway was as a member of the electrification subcommittee. In this he was engaged for three years, taking an active part in the detailed investigation of the project for electrifying the L.M.S. main lines Euston–Carlisle and St. Pancras–Leeds. In 1939 he retired from the railway service, and during the same year collaborated with Dr. H. F. Howorth in a paper entitled "Diesel Trains with Multiple Axle Drives," delivered before the Institution of Locomotive Engineers. Thereafter he spent four years as an Inspecting Officer under the Chief Inspector of Armaments, devoting himself later to consulting work. Mr. Hornbuckle was President during 1937 and 1938 of the Diesel Engineers and Users Association, before whom he presented a number of outstanding papers and to whose discussions he was a much-valued contributor.

Trans-Antarctic Transport

The successful completion, on Sunday last, of the Trans-Antarctic Expedition under the leadership of Dr. Vivian Fuchs owed much to work of many kinds which was done by engineers. Here, we survey generally the vehicles that carried the members of the expedition, and their equipment, over the 2200 miles of the most difficult terrain in the world. These vehicles included Sno-Cat, Weasel, Muskeg and Massey-Ferguson tractors, all of which were specially adapted for their task. The illustration on the right shows a " Sno-Cat " undergoing performance trials near Elvaeseter in Norway. At 7500ft above sea level, these vehicles were tried out over 250 miles of snow and ice.



LAST Sunday, at 1.47 p.m. (G.M.T.) the Trans-Antarctic Expedition led by Dr. Vivian Fuchs arrived at Scott Base. Their journey across Antarctica from Shackleton Base, a total distance of 2200 miles, was thus successfully accomplished in ninety-nine days, the expedition having set out from Shackleton Base on November 24 last. To synchronise with the exact time of the expedition's arrival at Scott Base, an announcement was made in London that Her Majesty the Queen proposed to confer the honour of Knighthood upon Dr. Fuchs. A congratulatory message from the Queen received later in the day by Dr. Fuchs referred not only to his success in a great enterprise but also to his " notable contribution to scientific knowledge."

To the success of Dr. Fuchs's expedition, and to the other Antarctic journeys which have been completed in recent months, engineers have made a notable contribution. The equipment essential for such an undertaking involved a tremendous amount of detailed planning ; there were so many " imponderables " that had to be taken into account. The major part of the engineering work was undoubtedly that associated with transport, for 2200 miles of Polar travel demanded vehicles that would withstand conditions of—to say the least—the utmost severity.

The planning of the British Commonwealth Trans-Antarctic Expedition started about eight years ago. Subsequently, early in 1955, the London committee of the expedition was set up under the chairmanship of Marshal of the Royal Air Force Sir John Slessor. A scientific sub-committee was formed, and the engineering work became the principal responsibility of Mr. David Pratt, the expedition's chief engineer and transport officer. One of the first tasks was, naturally, the selection of track vehicles considered to be best suited to the rigorous conditions demanded by the expedition. Investigations made by experts led to the choice of " Sno-Cat " " Weasel " and " Muskeg " tractors obtained from America and Canada, and, for some arduous work on part of the expedition, some Massey-Ferguson tractors, made at Coventry, were obtained. The American and Canadian vehicles were brought to this country and underwent extensive modification in various engineering establishments here to make them suitable for the 2200-mile Antarctic trek. The " Weasel " is a Canadian military vehicle, and the " Sno-Cat " and " Muskeg " are products of American and Canadian firms respectively.

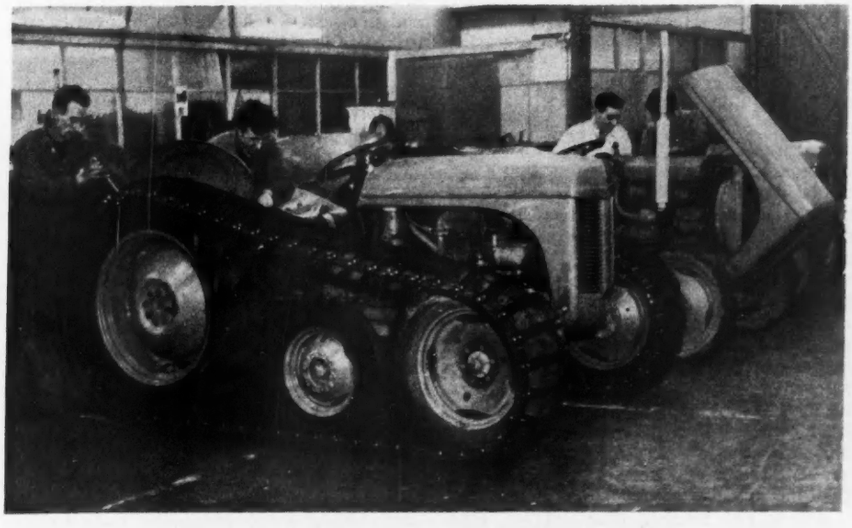
" Sno-Cat " being driven away from the " Magga Dan." The tractor is hauling 4 tons of petrol

Four " Sno-Cat " tractors were procured from the Tucker Sno-Cat Corporation, Medford, Oregon. The specially modified version of this vehicle is illustrated here, the photograph reproduced at the head of this article showing the tractor during trials which were carried out in Norway. The second illustration shows a " Sno-Cat " towing 4 tons of petrol away from the " Magga Dan " which reached the Weddell Sea from London in January 1957. An orthodox " Sno-Cat " is built up on a welded steel chassis the main body of the vehicle being of aluminium alloy. There are several versions of the tractor, among those selected for the expedition being a " utility double drive " and a " freighter double drive." The normal power units of these vehicles are 95 h.p. and 140 h.p. Chrysler engines respectively. In the "Sno-Cat " as built, traction over snow is dependent on the four sliding pontoons. The broad pontoon runners slide directly on the snow ; between each track link there is an open space several inches wide, through which the snow packs up against the bottom of the pontoon shoe thus providing a compressed surface on which the pontoon slides. The sharp propelling grouser links which are embedded in the compressed snow under each pontoon are firmly held by the weight of the vehicle and its load, which, the maker claims, provides positive traction in all kinds of snow. When power is applied to the driving sprocket, which is housed within the pontoon compartment, the link track is drawn around the pontoon, but since the grouser links are firmly held in the compressed snow and cannot move, the exerted force enables the frictionless pontoon to slide along the snow surface. Dodge truck transmission is incorporated and the normal cruising speed of all the " Sno-Cat " models is from 10 to 15 m.p.h. The largest of the vehicles used for the expedition is 20ft long and 7ft 10in wide, its turning radius being about 28ft.

As already mentioned, the vehicles underwent considerable modification in engineering works in this country. The engines, for example, were rebuilt by Chrysler Motors, Ltd., then batteries and other electrical accesssories were installed by Joseph Lucas, Ltd., who made a number of reliability tests in temperatures registering more than 80 deg. of frost. A great deal of the special instrumentation needed was carried out

Canadian-built "Muskeg" tractor powered by 115 h.p. engine. Its normal load is 2500 lb

by S. Smith and Sons (England), Ltd., and the fuels and lubricants were provided by The British Petroleum Company, Ltd. Other refinements included the installation of 36-gallon plastics tanks, special radio equipment, the addition of a power take-off and the fitting of escape hatches. Some indication of the scope of the engineering work which had to be done before the expedition could start is best given by recalling a talk which Mr. David Pratt broadcast in the B.B.C.'s general overseas service



Massey-Ferguson "TE-20" tractor being prepared for the Antarctic

in January, 1957.* In that talk Mr. Pratt said :

"An example of one of my development programmes is the method of heating our lead-acid batteries in the vehicles. For discovering the condition of the battery we have a capillary tube hydrometer for taking specific gravity, which again must be calibrated for temperature. A neat internal platinum resistance battery thermometer is ready spring-mounted on the vehicle dashboard. Having discovered the condition of the battery we may need to heat it, and this is done by seating the battery on a heater-pad inside a foamed-plastic lagged battery-box . . We have been carrying out a lot of cold-chamber tests all through the summer on our own vehicles, modifying the various systems. In fact, we have even run some of the rollers a 2000-mile journey inside a cold-box.

"Of course we have had to provide a full range of instruments for our engines, and to think carefully about tools and spares so that where possible one item will do two jobs. Weight is our controlling factor. When setting out, we weigh everything that is put on to the sledges. I have got some strain gauge dynamometers which will measure the drawbar pull, and we expect to be able to haul some four tons or more behind each "Sno-Cat." The amount we haul I expect to vary with the type of snow and temperature, and I hope that this gear will show that certain times of the day are the best times for travelling. I hope to investigate different materials for sledge-runners to obtain the least drag, and perhaps to find out some more information as to the cause of drag, so making over-snow travel more efficient and economic. The load on the sledge will consist in the main of food for the "Sno-Cat"—a very hungry animal with a consumption of 1·4 miles to the gallon of petrol. If the whole payload consisted of petrol only—four tons, that is to say 960 gallons of petrol—this would give us only 1384 miles. But our crossing is at least 2000 miles, so you will see that there is a balance of some 600 miles to be covered by the laying of depots. Naturally, the whole load cannot be petrol, since we must have food, tents, scientific equipment, tools, spares, oil and grease, as well as petrol. Thus to make a logistic success of the journey we shall not only have a depot 300 miles out from each end of the route but also we must expect to abandon vehicles at the most economic points and refuel the others with their remaining store of fuel.

"The situation will be well reinforced by aircraft. We have two aircraft—one Auster Mark 6 and one De Havilland Otter from Canada. The Auster Mark 6 can be used on floats from the ship for ice reconnaissance. The Otter is a single engined, fourteen seater high-wing monoplane which has a payload of 1 ton in addition to a long-range fuel tank invaluable for long inland flights."

The "Muskeg" tractor, illustrated herewith, is a product of Bombardier Snowmobile, Ltd., Valcourt, Quebec. It is a steel monoframe construction and the engine is a 115 h.p. Chrysler. The underside of the frame is very much akin to a toboggan, free from any protruding part, so that it slips over any obstacles which may be encountered. There is a double set of bogie wheels on each side of the tractor, assisting even load distribution and stability. The dual cross link tracks are each 29in wide, the endless rubber track belts being reinforced with steel cable. The "Muskeg" as manufactured has a turning radius of 15ft and its payload is 2500 lb. All its mechanical parts are entirely enclosed in the hull and frame so that there is maximum protection when operating in arduous conditions.

The British built tractor which has proved itself so well in Antarctica is the Massey-Ferguson TE-20, made by Massey-Harris-Ferguson, Ltd, Coventry. Altogether, seven of these tractors were employed by Dr. Fuchs and Sir Edmund Hillary during various stages of the expedition, and five others were supplied for the British and New Zealand parties directly concerned with the International Geophysical Year. During Sir Edmund Hillary's 1200-mile journey to the South Pole the performance of the Massey-Ferguson tractors was outstanding. At different times, it has been stated, they were drawing sledge loads of up to 3 tons. Our last illustration shows one of the tractors undergoing modification for work in deep snow and extreme cold. The tractors supplied were orthodox petrol-engined 28 h.p. machines. After delivery from the Standard Motor Company's Banner Lane Factory at Coventry their engines were run in for fifty hours on the test beds of Massey - Harris - Ferguson, Ltd., Special Lucas insulation was fitted to all the electrical wiring, with a larger starter motor and large-capacity batteries. Steering levers were provided to fix to the independent brake pedals, when using the full tracks. The brakes were fully enclosed and sealed to keep out condensation and driving snow. Without these seals there would have been the danger of ice melting inside the brake housing, freezing again and then tearing the brake linings off their shoes. Grease nipples were fitted to the clutch and brake pedal shafts and special grease used to prevent freezing up.

Extra side plates were added to keep snow out of the engine. Goodyear natural rubber tyres were fitted, to ensure they did not go hard under intense cold. Shields were fitted to provide as much protection as possible to the driver, without obscuring his vision or handling of the tractor. The full tyre tracks to wrap around the front and rear wheels were specially designed for the expedition. The object of these tracks (they were described in THE ENGINEER, July 6, 1956), is to provide an endless "mat" for the tractor wheels. The tracks, which are rubber belts joined by steel cross members, fit over the back tyres of the tractor and over idler wheels connected to brackets beneath the back axle housings. There are compression springs which force these idler wheels downward for adhesion and forward to promote the necessary degree of track tension as the idler wheels move vertically from front to back.

* *London Calling* (B.B.C. publication).

Transport Speeds

By SIR GEORGE EDWARDS, C.B.E., B.Sc., F.R.Ae.S.

In his Presidential Address to the Royal Aeronautical Society, delivered on February 26, Sir George Edwards traced the history of transport speeds from the eighteenth century onwards. He saw a connection between industrialisation and a demand for higher transport speeds and conversely higher transport speeds stimulating industrialisation. In conclusion, he suggested that though in the 'sixties jet transports will continue to operate at subsonic speeds, in the 'seventies supersonic jet transports will appear and bring practically any part of the world within twelve hours' journey time from anywhere else. Decisions about future development should be made with that concept in view. We print here abstracts from the lecture.

I AM going to try to show the way in which speed in transport has developed and the way that the demand for more and faster transport was stimulated by the world's communities becoming industrialised. Also that, in the same way, and in a kind of " chicken and egg " relationship, the presence of more and faster transport enabled the world's communities to become industrialised and to expand. You will not be surprised to find that some of my conclusions indicate that the further development of speed in transport is likely to rest with the aeroplane.

At the end of the seventeenth century, a pedestrian in twelve hours (a day's journey time) could have gone 20 miles. The horse-rider, we have established, was able to do 30 miles in his day, which got him on the one hand as far as Reading or in the other direction a little beyond Maidstone. If you were rich or, alternatively, ran an expense account, you could travel in a coach and do 75 miles in the twelve-hour day.

A hundred years later a twelve-hour journey covered pretty well the whole of Britain and also went into the Channel countries. Here, in a day, the distance had jumped from the 75 miles a century earlier to 250 miles where water was in the way, and to as much as 550 where it was not. So that from the year dot until the age of the Industrial Revolution, 75 miles was as much as could be managed in a day. But stimulus of the Industrial Revolution during the nineteenth century produced an increase in the day's journey distance from that 75 miles to over 500. Making a jump from 1895 to the present century, we need a map that goes a bit further than the one covering the Home Counties and a bit of France. We need one of the world. In 1920 one could go only 560 miles, little further than you could go in 1895. This is a reflection of the fact that surface transport had not done much between 1895 and 1920 and air travel, of course, had barely started. By 1930 the twelve-hour distance had gone up to 760 miles ; by 1940 up to 1250 (by which time we were covering a large part of Europe). By 1960, allowing myself the anticipation of big subsonic jets, the distance may reach 5500 miles. The chief thing to notice is not so much the distance that one will be able to go in twelve hours in 1960, but the amount of the world that still remains uncovered by a twelve-hour journey from London. The distances prior to 1960 are all taken from air guides and air time-tables. The 1960 figure may be 10 per cent optimistic, due to routing. I want to go back now to consider the growth of the United Kingdom population. The Industrial Revolution started shortly after 1800 and there was a sharp increase in the population growth curve. There was also a sharp increase in the distance of a day's travel. The inter-relation between these two could well be the subject of yet another lecture. It is clear that the increase in industrialisation which came with the Industrial Revolution, in turn, brought about an increase in population and a greater demand for more and faster transport. This increase in travel stimulated business and, in turn, increased industrialisation and with it the population. The reference books are unclear as to why this sharp increase in population in fact took place at that time. There is no evidence that fertility varied appreciably. The most likely cause is that the mortality rate, especially the great mass reducers of the population such as famine and plague, had been stemmed. The facts of life, however, are that the population did increase at the time of the Industrial Revolution and at the time of the increase in transport. I think it is pretty obvious that there is a definite connection between industry, population and speed of transport.

Next I want to examine two famous routes, one across the North Atlantic and the other across the Irish Channel. The big difference between the time that it takes to cross the Atlantic by air and sea needs little comment. In 1957 air and sea transport each carried a little over a million passengers. The increase in air in the post-war years is pretty dramatic in that it has virtually quadrupled since 1948, but it is also interesting to note that there has been an increase in sea travel at the same time, although not nearly so great. It could be that the upsurge of air travel has had a stimulating effect on this total.

If we look at the Irish Channel we find that a journey by train and boat from London to Dublin takes ten hours twenty-eight minutes, whereas the air route from London to Dublin takes three hours and ten minutes (centre to centre), a gain of seven hours eighteen minutes. The total traffic, which has doubled, has been helped significantly by the attraction of the air route. This has grown from almost nothing to a quarter of the total travel.

Air is not cheaper than sea on either London to New York or Birmingham (I have chosen Birmingham for a reason I will explain later) to Dublin. In actual fact, the cheapest form of crossing the Atlantic or going to Ireland is by surface travel. Now, bearing in mind that the cheapest way to go to Ireland is by sea, it is interesting to subdivide air traffic into income groups. The interesting thing here is that the increase over the last seven or eight years has not, as you might expect, come from the higher income groups, but has, in fact, come from the lower income groups. The number of people in the higher income bracket has stayed fairly constant, whereas the lower income group figure has almost doubled over the last seven years. On the Birmingham–Dublin route the lower income group content is some 70 per cent of the whole. This, I think, is a pretty positive demonstration that speed will encourage travel even though it will cost more, and I think another interesting thing about the Irish route is the fact that it is a short-haul, unglamorous leg in comparison with the North Atlantic. The latter, of course, is the dramatic route always quoted for comparisons in time saved in travelling by air.

I should also deal briefly here with " expense account travellers "—who, unlike the lower income groups, are not historically concerned with fare rates. Their journeys are " on the firm " and it is not surprising that speed is chosen every time. What does emerge from a general study of business travel, however (and this has been backed up by such figures as are published on this subject), is that when a destination gets beyond the twelve-hour journey circle journey incidence falls sharply. There is much business flying inside the " twelve-hour circle "—in fact, half of it. There is a further one-third on journeys of twenty-four hours and only one-sixth to the more distant places—even though they include South America, Australasia, the Far East and a lot of South-East Asia. There is a moral there somewhere. I want to draw your attention now to the way in which surface transport speeds have developed over the last 150 years. The speeds of ships and trains, especially the latter, developed fairly rapidly up to the early years of this century and then largely levelled out. The diesel and the diesel-electric have since given a small increase. But this is a picture in general of speeds being limited by some artificial factors such as those imposed by tracks and hull design. But the great strength of the aeroplane lies in its freedom, so far, from artificial restrictions on cruising speed. At this point I think some of the sinister motive behind this talk will be coming clear, and in case it is not I think I had better try to make it clear. It is, put simply, that increasing speed in transport has been the essential hand-maiden to increasing development all over the world and that the only medium in which speed can continue to increase is the air. There is no indication that a demand for increasing speed is going to diminish or disappear, so that the demand for faster aeroplanes is likely to go on. Having said that, let me make it quite clear that there will be, in my opinion, a whole lot of operations which are better conducted by an aeroplane not necessarily in the top speed range. The dramatic cutting down of journey time compared with that of surface transport is an advantage shared by all modern aircraft. We have shown that these big savings of time attract the traffic to the aeroplane as a vehicle even despite higher fares. The speed range of aeroplanes themselves is, however, scattered over a fairly wide band, but they all have, to a greater or lesser degree, a dominating speed advantage over surface transport. People—and I mean people in the mass—are preferring air travel. But—and this is an important point—having chosen to fly, the actual airborne vehicle selected will depend upon overall economies.

Speed increases in the air, up to now, have, by improvements in the state of the art and by much labour, always been accompanied by better economies and efficiency. Any reversal of that trend would be a set-back for civil aviation and would halt the present flow of mass travel towards the aeroplane.

Speed improvements as between aeroplane and aeroplane must be related to the job in hand and also to the economic " rate for the job." Speed by itself and for its own sake can be a false god and pursuit of it is unhealthy. I believe there will, in fact, be significant speed gains for aviation—and I am about to evaluate their probable immediate size—but I do it with the warning that these gains must be based on sound overall

economy and efficiency of operation.

The history of air speeds up to the present time shows a dramatic increase of as much as 50 per cent in the world air speed record over the last two or three years and a steady progression of civil transport cruising speeds and, for that matter, of bombers. There has, however, been a stepping up of bomber speeds with the advent of the post-war " B.45 " and " B.47 " followed by the " V " bombers. By 1965 somebody may have, and could have, a supersonic bomber capable of flying at M 2·5 (although I have no idea if there will be such an aeroplane). Cruising speeds of propeller-driven transports seem unlikely to go above 500 miles an hour. Neither of these assumptions is terribly difficult to make, but I must say again that the bomber one is merely what I think could be done—I have no knowledge that it is going to be. The really difficult thing to do is to project the transport curve. Here I think we have to learn from the shape of the bomber curve, and, before it, the speed record curve. It seems to me that the subsonic jets, such as the Boeing and the Douglas and the others, are in themselves going to produce something in the nature of a speed plateau and I think the airline's financial situation will stop them being replaced for some considerable time. So I venture to say that subsonic jets will continue to do their 600 miles an hour or thereabouts right through the 1960s. There seems, however, to be no technical reason why the supersonic development of the world's air speed record (and the supersonic bombers which could follow it) could not also be followed by supersonic transports, flying at speeds of over 1000 miles an hour. If one decides that the gaps which have existed between the world's air speed record and bomber speeds and transport speeds will be maintained then there is no reason why civil jets should not be in existence at supersonic speeds in the 1960s. I believe, however, the financial burden of depreciating the subsonic jets will alone make that impossible, and a supersonic jet in operation before 1970 is of academic interest only. When we do get a supersonic jet we get with it the ability to bring practically the whole world within reach of the twelve-hour journey time. I have tried to show that there is an increasing demand for a longer distance to be flown in twelve hours. I am certainly convinced that nothing will stop the ultimate operation of long-range supersonic civil aeroplanes. I believe that the operating costs when the time comes will be within reasonable distance of the operation costs—as we know them—of the subsonic jets. If I might hark back to my early word about our friends, the Americans, and the position that we the British hold to-day in the West—we have all the operating experience in turbine-engined transport with a propeller-turbine or prop-jet, and I see no reason why we should not have our own great stake in this new field of supersonic civil travel. In my audience to-night are many important people who will have the responsibility of making decisions that will decide whether, in fact, there are to be British supersonic transports. If I have done something in this lecture to demonstrate that those decisions should be taken with a view to ensuring that there will be, then my time will have been well spent. If it is true that we are not going on with a supersonic long-range bomber, then let us spend the money on a supersonic long-range transport. This should not be hampered by following the basic design for a specialised military application in which economy is not a major factor. Let us make a virtue of necessity and put our effort into an optimum civil aeroplane.

Gas Plant Projects in Britain

AN order has been placed for the construction of a " Lurgi " plant for making gas from low-grade coal at a new works at Westfield in Fife, of the Scottish Gas Board. This plant, to cost some £6,500,000, will have a production capacity of 30,000,000 cubic feet of gas per day, and at an interim stage in its construction will have an output of 15,000,000 cubic feet per day. It will use coal containing up to 25 per cent ash and 16 per cent moisture, normally unsuitable for carbonising plant use. This coal will be supplied by a belt conveyor system from nearby open-cast workings.

The main contract for the new works has been placed with Humphreys and Glasgow, Ltd., which company, in association with the Power Gas Corporation, has reached an agreement with the Lurgi Company of Germany to build the generator equipment. In these generators coal is completely gasified at a pressure of about 25 atmospheres in a continuous stream of oxygen and superheated steam. Heat in the crude gas from the generators will be used to produce steam in waste heat boilers. Tar, oils, ammonia and benzole will be recovered. The proportion of hydrogen in the gas is to be increased by a catalytic conversion plant and carbon dioxide " washed " out in a " Benfield " plant. The gas will then be enriched by the hydrogenation of oil process developed by Dr. F. J. Dent, Director of the Gas Council's West Midlands Research Station, where Humphreys and Glasgow has already built a 1,000,000 cubic feet per day hydrogenation pilot plant.

The gas will finally pass through a further benzole recovery plant, recovering high purity benzene, before passing through pressure oxide purifiers, in which the final traces of hydrogen sulphide will be taken out.

The Lurgi generators will give a crude gas having a calorific value of about 300 B.Th.U. per cubic foot. Ultimately the output of purified Lurgi gas will be about 22,000,000 cubic feet per day, and when enriched in the subsequent processes this will give the total output of 30,000,000 cubic feet per day. The plant, with an associated system of high and medium pressure grid mains, will take some five years to complete, and the total cost of the project, including the distribution system, will be about £8,454,000.

Another gas project of interest is to be installed at the Partington works, Manchester, of the North Western Gas Board, by Humphreys and Glasgow, Ltd., at a cost of some £2,000,000. It is stated that one of the main objects of this plant is to hasten full-scale development of a new process to produce gas by hydrogenation of oil or coal, first envisaged by Dr. F. J. Dent.

The plant will produce town's gas by a sequence of continuous automatically controlled processes which have been designed by the process engineering department of Humphreys and Glasgow, Ltd., under its technical director, Mr. N. H. Williams, in collaboration with the development department of the North Western Gas Board. A wide variety of different grades of oil can be used in the process, thus taking advantage of fluctuations in the price of oil refinery by-products, and later it is intended that low-grade coal will take the place of oil. The installation at Partington will have a capacity of 7,500,000 cubic feet of gas per day and it is claimed that gas made in this demonstration plant will cost roughly the same as gas produced by conventional methods, but for bigger plants considerable reductions in both capital and operating expenditure would cut costs sharply.

The gasification system of the new Partington plant will comprise the production and purification of hydrogen in excess of 90 per cent purity by the gasification of oil at a pressure of 400 lb per square inch with oxygen and steam, and the use of this hydrogen for the production of rich gas by hydrogenating further oil or coal to produce gas of about 600 B.Th.U. per cubic foot calorific value. The rich gas is then diluted to the required calorific value by the addition of nitrogen. The system has the advantage that both the specific gravity and the carbon monoxide content of the gas are under control. In this first installation it is intended that the carbon monoxide content of the gas should be at least as low as 1·5 per cent or under, thus greatly reducing the toxicity of the gas. The organic sulphur content of the gas is also very low.

The process used for the production of hydrogen is that of the Texaco Development Corporation, in which oil is gasified by reaction with steam in oxygen at a temperature of approximately 2500 deg. Fah. The resulting gas produced at this stage is a mixture of carbon monoxide and hydrogen, together with a small amount of carbon dioxide and traces of methane. A controlled amount of carbon black is formed which is removed from the gas by a water wash which simultaneously generates the steam necessary for reacting with the carbon monoxide to form hydrogen.

The gas leaving the scrubbers is passed to a carbon monoxide conversion plant, where the shift reaction is carried out over a sulphur-resistant catalyst. The carbon dioxide and hydrogen sulphide in the gases leaving the shift converters are removed by absorption in a solution of potassium carbonate at a temperature of approximately 250 deg. Fah., using the Benfield process. The absorbent solution is regenerated by reducing the pressure and stripping with steam derived from the hot gas stream coming from the conversion plant.

The gas leaving the Benfield absorber, consisting of at least 90 per cent hydrogen, is preheated and fed into the hydrogenator, together with preheated oil which is converted at high temperatures essentially to methane, together with a proportion of ethane. This hydrogenation is the key section of the process and was conceived and developed to the pilot stage by Dr. Dent at Solihull Research Station of the Gas Council. The gases leaving the hydrogenator contain benzene and highly aromatic compounds which are removed by condensation and scrubbing with circulating oil. The resultant gas, free of benzene, is then diluted with nitrogen to bring the gas to the required calorific value and density.

London Helicopter Terminal

APPROVAL for the construction of a " heliport " on the Thames in London has been sought by Westland Aircraft, Ltd., which builds helicopters under licence from the Sikorsky Division of United Aircraft Corporation. The facility would resemble the new riverside helicopter base in New York, the actual landing area being over the river to allow single-engined aircraft to approach without flying over a built-up area ; an aircraft park would be provided on the bank. This proposal is intended to furnish a temporary base which would be made available to any operator to use ; it is expected that it would enable the commercial development of the helicopter as applied to traffic through and from city centres and large industrial areas to be further explored.

Westland is aware of the existence of a charter demand for the carriage of merchandise by helicopter, e.g. press photographs, films and urgently required engineering spares. There is also an immediate and probably growing use for helicopters for bringing emergency cases to London hospitals. There is a demand by large organisations to fly important people to and from the centre of London, and for the development of connecting links between the centre and the existing London Airport. The location of the heliport will be in an industrial zone so that there will be no inconvenience to residents ; at the same time it will be readily accessible from points in the city and west end.

The local authorities in many towns and cities have for some time past been displaying an active interest in the progress of all practical helicopter operations and in some cases preliminary steps have been taken to earmark sites for heliports. There is, however, an understandable hesitation to spend money on such projects until a lead has been given by the capital.

LETTERS AND LITERATURE

Letters to the Editor

We do not hold ourselves responsible for the opinions of our correspondents)

RAILWAYS INTO ROADWAYS

SIR,—The four letters on "Railways into Roadways," in your issue of February 28, 1958, in effect invite a brief restatement of the basis of the case for railway conversion. That case springs from the statistical fact that were British railways turned into roads, reserved for fast motor traffic, their capacity would be so vastly increased that the present volume of rail traffic, carried in suitable motor vehicles, would appear insignificant upon them.

In establishing that fact it has been unnecessary even to refer to a lane loading of more than 1000 vehicles per hour: the discrepancy between Mr. Clayton's theoretical lane capacity of 2000 v.p.h. and Mr. Barbour's observed 2900 v.p.h. is therefore irrelevant at this stage. And when Mr. Clayton refers to forty trains per hour in a London tube it is also an irrelevancy; for, above ground and again statistically, typical railbeds, converted into roads reserved for suitable vehicles, can be shown to have not less than twenty times the capacity they actually had as railways. The corollary and, indeed, the vital aspect of the proposal, is there will be ample space on the converted railways for them to become a separate, 19,000-mile motor road system, relieving our overburdened highway system of all speed-worthy traffic. Our mounting volume of road traffic demands measures of that order.

Three other questions arose in the letters: speed and comfort; widths; safety. Are not the speed and comfort of a railway journey due to the "way" rather than the vehicle? And cannot civil engineers and motor vehicle designers promise us that there will be no "bouncing on rubber and air"? It is satisfactory to be reminded by one correspondent that four-tracked railways will convert immediately into full-scale dual motorways. There are more than 1500 miles of them and they lie precisely where they are needed. Elsewhere, if widening is needed, let us remember that the Stephensons and Brunel faced virgin land.

The greatest single factor in road safety is "limited access"—the segregation of fast motor traffic. American experience indicates that it reduces accidents by 65 per cent: their 40,000-mile Inter-State system of motor roads is expected to save 3500 lives a year. Surely the converted railways would do as much, in proportion, for Britain.

T. I. LLOYD

London, S.W.1,
March 4, 1958.

SIR,—The correspondence upon your editorial (January 31 issue) on Brigadier T. I. Lloyd's proposals for using the British Railways as a reserved roadway system has so far been confined to the converted enthusiasts of such a scheme, particularly in the case of Mr. E. C. Gordon-England on behalf of the Railways Conversion League.*

All your readers may not be aware that Brigadier Lloyd first expressed his proposals in a paper in the *Royal Engineers Journal* and then he presented a paper in April, 1955, to a very full meeting of the Institution of Civil Engineers. Although the civil engineering profession and industry would welcome the vast expenditure involved, economists are unlikely to consider it a desirable capital investment and in consequence the speakers and contributors in writing to the discussion were mainly concerned with constructive criticism. A study of this discussion which appears in November, 1955, (No. 6) issue of the *Proceedings of the Institution of Civil Engineers* might do much to reduce uninformed correspondence on a complex subject which I suggest could be studied from the following four selected fundamental points which were not answered satisfactorily at the meeting mentioned.

(1) High variable speeds necessitate dual carriageways for safety in which case the existing railway formation widths cannot be adopted for a roadway system. The minimum roadway required is 60ft (not motorway width) whilst a double track railway is only 30ft (19ft to 22ft in tunnels and retaining walls) and quadruple track is only 55ft wide which would in most cases limit the new roadways system to single 22ft carriageways.

(2) The practical difficulties of constructing roads whilst maintaining essential railway traffic are so enormous that it would be economically impossible to make a conversion without first dispensing with railway traffic.

(3) The railways function satisfactorily, with reduced efficiency, during fog, ice and heavy snow whilst the proposed new roadway system would be paralysed in exceptional weather conditions.

(4) Would thousands of buses be a satisfactory substitute for handling the rush hour passenger traffic to and from London?

Your correspondents quote the estimated future high increase of vehicles on the roads, but ignore that railways are ideal for relieving the congested roads of much freight, particularly so-called indivisible loads, if only the British Transport Commission would provide competitive facilities to that of road haulage.

A. A. OSBORNE

Farnham, Surrey,
February 26, 1958.

EARLY LAWN MOWERS

SIR,—With reference to the article by Mr. G. E. Fussell in your issue dated February 21, I was shown one of these early Ransomes, Sims and Jefferies mowers a few years ago. This machine was apparently in perfect condition but no longer used, having been superseded by lighter modern machines. It stood—and probably still stands—in an outbuilding at Prested Hall, Feering, Essex, just off the main A12 London-Colchester Road. I should think that this machine is worthy of preservation in a museum, or by the makers, as there cannot be many left in such good shape.

L. E. SHELLEY

East Sheen,
London, S.W.14,
February 25, 1958.

* Mr. Osborne's letter was received just too late to appear in last week's issue with other letters critical of Brigadier Lloyd's proposals.

Book Reviews

Hydro-Electric Engineering Practice. Vols. I, II and III. Edited by J. GUTHRIE BROWN, M.I.C.E. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price: Vol. I, 9 guineas; Vol. II, 6 guineas; Vol. III, 4 guineas.

THESE three volumes are described by the publisher as "a major scientific work . . . by far the most extensive and detailed so far produced in any country dealing with hydro-electric engineering . . . which will break the monopoly held for many years by American text books." The three volumes deal respectively with civil engineering; mechanical and electrical engineering; and economics, operation and maintenance. Twenty-five specialist contributors have written the various chapters. They have been chosen principally from the staffs of well-known firms engaged in hydro-electric work—Sir Alexander Gibb and Partners, Messrs. Merz and McLellan, the English Electric Company, Ltd., Boving and Co., Ltd., and the Metropolitan-Vickers Electrical Company, Ltd. British practice is therefore the principal concern of the three volumes; however, Continental practice is exemplified and occasional references to United States practice remain unexpurgated.

Hydro-electric construction in Great Britain has always been on a rather small scale. But the contribution of British technical thought has been of greater significance than the scale of these works at home would indicate, due to the traditionally widespread activities of consultants and contractors overseas, and to the vigorous export of water turbines and similar plant. A basic, comprehensive, text-book to support all this activity is therefore especially welcome. Generally, the book is pleasantly written and well produced, and it is claimed that much material which is new to any textbook is included in it. The problem of selection of topic and treatment in a book of this kind is obviously a difficult one, and the fact that all the authors are actively engaged in hydro-electric work seems the best guarantee of a practical solution and also of obtaining a reliable and practical text.

The Achilles' heels of twenty-five specialists cannot be readily perceived by one reviewer. One general impression remains, however: the book has taken ten years to complete, and although revision up to the publication date is claimed, it would appear that the long period of preparation has left its mark, in that the most recent work is not dealt with quite so fully as would be desirable, and in some cases not at all. The strong point of the book, by contrast, is that part which deals with the basic, relatively unchanging,

approach to design, construction and operation.

In a book extolling British practice, it would be expected that the most recent advances made in this country would be given especial prominence. Two such recent advances of importance come to mind, namely, the research and model tests on arch dams using the relaxation method, and the introduction of a reversible pump turbine with adjustable blades—the " feathering Francis " machine. Both of these innovations are mentioned, but neither, we suggest, are given the prominence which they deserve. Gates and valves, also, are not explained quite comprehensively : the straight-flow valve, and the lowering crest gate—fairly recent introductions which are becoming widely used—are principal omissions, but some other recent Continental developments are not mentioned.

The preface stresses a future trend which is likely to be characteristic especially of British practice, namely, the use of hydro-electric energy in conjunction with nuclear power. Nuclear power stations would cater for base loads, in a system of this kind, and the hydro-electric stations would be reserved for peak loads—perhaps to a greater extent than they are now—with an increasing emphasis on pumped storage. In fact, there is promise of considerable development in pumped storage over the next decade or so. The subject is dealt with quite fully in two places in these volumes, but again a really up-to-date appraisal of certain aspects is lacking, as would be inferred from our previous criticism of the treatment of the Francis pump-turbine. Perhaps it was too early to mention either of the large British projects—Loch Awe, in Scotland, and Ffestiniog, in Wales—although we think an outline description might have been worth while. Another interesting example is the chain of peak load stations on the River Ill, in Austria, and the Lunersee pumping scheme which is associated with them. The way in which this scheme caters for seasonal and daily peaks, and for " peaks " of relatively short duration, say, twenty minutes, is particularly instructive, and might have been described as an example of present-day trends.

By contrast to these topics which we have suggested as examples of omissions—most of which, it may be noted, would themselves be " dated " in a few years—parts of the subject matter of the three volumes are rarely touched upon in text books. In particular, Volume III is praiseworthy for the attempts to discuss operation and maintenance of hydro-electric plant, and the economics of such plant and of mixed hydro and thermal systems. Throughout the three volumes, the style of presentation is agreeable and a great deal of information is presented in a simple and straightforward way.

About half of the bulk of this treatise is contained in Volume I, on civil engineering. Rainfall and run-off and flow measurement are first discussed, followed by chapters on hydraulics and hydraulic models. The next section of Volume I is called " The planning of the scheme," and has chapters on the basic principles of development, overall aspects of design, and site investigations. Then, the design and construction of civil engineering works is tackled systematically : gravity dams, embankment dams, arch dams, and other types of dam, each have a long chapter. Then we come to chapters on spillway and flood control works, intake works and equipment, outlet works, and canals and channels. Pipes and aqueducts, tunnels, surge chambers, steel pipelines and valves and water hammer are dealt with in the next group of five chapters, followed by chapters on power station design and underground stations ; finally, æsthetic considerations and fishery requirements are discussed.

Mechanical and electrical engineering in Volume II are treated under four principal headings. The first, water turbines, has chapters on general principles, on each of the principal kinds of water turbine, on governing and on testing. The second heading is " generator plant," a topic which is discussed in four chapters, and which is followed by a lengthy section on control and transmission equipment. Finally, power station planning is discussed, as it relates to the plant, in four chapters.

The last volume is more general in some respects and includes a review of world power resources, followed by expositions on cost and economic analysis of hydro-electric projects. Operation, pumped storage and multi-purpose schemes are also discussed. There are then a series of chapters on various aspects of planning and development and on the preparation of reports and estimates. A major section of this volume comes under the heading of " operation and management " ; this includes chapters on maintenance. Appendices are included on wind power, medical aspects of reservoir construction, and nuclear power.

Rockets, Missiles and Space Travel. Revised Edition. By WILLY LEY. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 50s.

THIS is a completely new and enlarged edition of a book first published in Great Britain in 1948, revised and re-published in 1951, and later twice re-printed. Its past success has been not merely because the subject matter was becoming of more than specialised interest, but also because it was presented in a very interesting and simple fashion. The present edition retains these characteristics and with current rocket developments featuring so prominently in world affairs, it is now more than ever worth while for all who profess more than a passing interest in the subject. The author is well qualified to expound it. He began writing on rockets in 1926 and he was one of the earliest members of the pre-war German Rocket Society which flourished almost thirty years ago. A photograph in the book shows him with other well-known pioneers including Von Braun of V.2 and, more recently, American satellite rocket fame. He preceded Von Braun to America by ten years but remained as much devoted to rockets as his former colleague. He has, too, the gift of writing with vivid description and interesting anecdote allied to simple layman's explanations of the many puzzling problems of space flight.

The book is divided broadly into two—history up to the time that rockets became really practical missiles during the 1939-45 war, and present and future developments. The historical section has not been altered in this new edition. It begins with the conception of space in the days of ancient Greece and progresses through fact and fiction to the days of modern astronomy. It shows how Kepler, Galileo and Newton advanced our knowledge and how writers like Cyrano de Bergerac, Jules Verne and H. G. Wells stimulated our fancies. It continues with the studies of rockets and their uses from the days of medieval China through the Napoleonic war rockets of Congreve to the theories of Ziolkovsky, Oberth and Goddard, the pioneers of modern rocket techniques. A chapter is devoted to the wartime developments of solid propellant rockets and their applications followed by the story of Peenemunde. It is at this point that contemporary developments begin and the triumphs and tribulations of those engaged in them is related with much detail. In fact, nobody reading the account of early V.2 launchings at Peenemunde and Viking tests at White Sands will be surprised any longer at the vicissitudes of the Vanguard satellite rocket. Part of the new material included in this book is a tabulation of the results of the first thirty firings of the V.2. Of these only five could be called completely successful and more than half failed during the initial take-off phase.

Apart from such additional matter, a whole new chapter is introduced into the following section, which deals with the many problems of space flight and the steps to be taken in achieving it. This no longer has the air of a doubtful future possibility, but introduces the satellite vehicle and the logical next steps with much confidence. These are supported by descriptions of experimental work already carried out on physiology, study of meteorites, cosmic radiation and other space hazards. Much new information is included in the appendices. There is a note on the legal aspects of space travel, a description of Von Braun's transport rocket for establishing a space ship and, for those interested in more immediate matters, the story of the flight testing of the American " Skyrocket " aircraft.

There is also a great deal of information on American missiles and some reference to French and British rockets. The latter is very sparse and probably the only part of the book where the statements are not entirely reliable. In other respects, no serious criticism can be made. The book is well illustrated, both with photographs and diagrams, and there is an excellent index and a bibliography covering books and periodicals in many languages. It is quite useful for reference in many topics and can be recommended to both layman and expert as giving very valuable background information.

Books of Reference

American Civil Engineering Practice Vol. III. Edited by R. W. Abbett. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 200s.—Volumes I and II of this encyclopaedic work of reference were reviewed in our issue of March 15, 1957. Here, we may recall that each subject has been contributed by a well-known American authority, and the book is intended to be a comprehensive source of reference in the entire field of civil engineering, presenting the fundamentals and techniques of that subject as they are commonly applied in the United States. Volume I dealt with planning, road, rail and airport construction, and soil mechanics and relative subjects including tunnels. Volume II covered hydraulic, sanitary and harbour engineering. The volume reviewed here is concerned with masonry, reinforced concrete, steel and timber structures.

A more precise idea of the contents of the third volume can be given. The theory of structures is expounded in the first chapter, with a review of fundamentals and principles, presented principally for reference. Masonry and plain concrete, reinforced concrete, detailed design in reinforced concrete, and prestressed concrete structures are all dealt with in some detail. Then practice in the design and construction of footings, piers and abutments, and of retaining walls is explained. Steel bridges and reinforced concrete bridges are each the subject of a long chapter. The general heading " Buildings " is sub-divided into three main sections on structural planning, reinforced concrete and steel buildings respectively. More specialised structures in steel and reinforced concrete respectively are dealt with in the next two chapters, towers, tanks and cold-formed construction being covered in the first case, and chimneys, silos, tanks and turbine foundations in the second. Finally, there is a chapter on timber structures, and one on earthquake-resistant design.

Semi-Conductor Rectifier Factory

The use of semi-conductors for high-power rectifiers has been a particular interest of the British Thomson-Houston Company, Ltd., since before 1952 *when the large area p-n junction was introduced. In* 1953 *the first* 300*kW germanium industrial power rectifier was built at Rugby. The germanium cell which is the basis of this kind of industrial rectifying equipment was originally made in the company's research laboratory. As it was clear that the future demand for these rectifiers would grow, in view of their high efficiency and small size, the company decided to build a new self-contained factory where superior conditions of clinical cleanliness, now proved to be essential in this class of work, could be applied to quantity production methods. A brief description of the manufacturing processes, the factory and other relevant points of interest is given here.*

ALTHOUGH some of the characteristics of the materials now known as semi-conductors were first observed more than 130 years ago, it was not until the early days of radio that these materials, because of their rectifying properties, found much practical use. Galena or silicon formed the basis of the once familiar "cat's whisker" crystal which, although it was a temperamental device, served as a detector of r.f. waves until it was ousted by the thermionic valve. Soon the crystal detector became little more than a symbol of obsolescence, but it experienced revival during the second world war when the introduction of centimetric-wave radar created a demand for a sensitive detector at very high frequencies and the silicon "cat's whisker" crystal was brought up-to-date for the purpose.

These latter developments were very much the concern of the British Thomson-Houston Company, Ltd., and when near the end of the war the emphasis shifted towards the use of germanium, the company produced the first germanium rectifier for the lower radio-frequency applications. The invention of the transistor in the Bell Telephone Laboratories in 1948, the introduction of *p-n* junction devices in 1950, and the subsequent development of the large-area *p-n* junction rectifier in 1952, laid the foundations for increasing the use of semi-conductor devices in all phases of the electrical industry.

At this stage it may be useful to explain the function of a semi-conductor device. Generally, such a device consists of a piece of semi-conductor material, such as germanium or silicon, which has been suitably processed to produce rectifying barriers (usually called *p-n* junctions) and two or more ohmic contacts to which the appropriate external connections can be made. There are three main kinds of semi-conductor devices—rectifiers, transistors and photoelectric cells. The semi-conductor rectifier is a diode, that is, a two-terminal assembly, with an asymmetrical voltage/current characteristic which makes it effectively conducting in one direction only. The transistor is a semi-conductor assembly with three or more terminals and, like the triode valve, it is capable of amplifying an input signal. The photoelectric cell is a semi-conductor assembly in which the current/voltage characteristic depends on the incident illumination.

The present article is concerned only with the first group, the semi-conductor rectifier, as developed for power applications by the British Thomson-Houston Company, Ltd. In 1953 this company produced what is believed to be the first high-power high-voltage germanium rectifier in Great Britain; it had a continuous rating of 300kW and consisted of racks of cells connected in series parallel, each cell being a sealed self-contained germanium rectifier fitted with cooling fins. Usually the racks of cells are enclosed in a cubicle and are forced-air cooled by an extraction fan mounted in a cowling at the top of the cubicle. The latest installation completed by this company is that of a germanium power rectifier rated at 18,400kW, 8000A, 230V, at the Ellesmere Port works of the Associated Ethyl Company, Ltd., as described in our issue of February 7, 1958, page 222. Part of this rectifier with one of the racks withdrawn to show the banks of cells is illustrated in Fig. 1: it supplies power for the electrolytic production of chlorine.

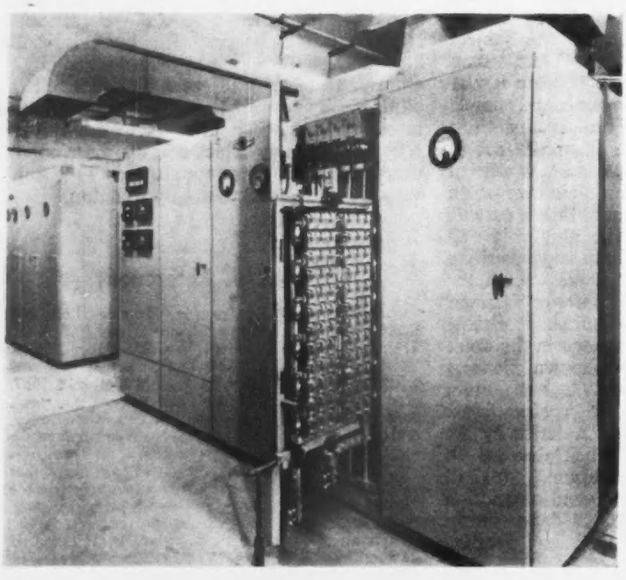


Fig. 1—Part of the 18,400kW germanium power rectifier at the Ellesmere Port Works of the Associated Ethyl Company, Ltd. One of the racks is withdrawn to show the banks of rectifier cells

Another very important application in which B.T.H. has pioneered the introduction of semi-conductor cells is in the field of electric traction, and an electric train equipped with germanium power rectifiers has already been in service on British Railways for over two years.

A typical germanium rectifier cell of the kind used in these applications is illustrated in Fig. 2, and typical electrical characteristics are reproduced in Fig. 3.

New Semi-Conductor Factory

For the successful manufacture in quantity of semi-conductor cells such as these, it is essential that the highly specialised conditions of a development laboratory be reproduced at the production benches. The efficiency of these devices depends primarily upon the initial purity of the germanium or silicon used for the rectifying element; ideally the impurity level should, if possible, be less than one part in a thousand million. Clearly, therefore, very special precautions must be taken throughout the manufacturing process to protect the materials from contamination by handling or air-borne dust and foreign matter in the normal industrial atmosphere. Additional precautions are also necessary to insulate certain of the production operations from mechanical and thermal shock, and the maintenance of high standards of chemical purity of treatment and washing operations is of vital importance.

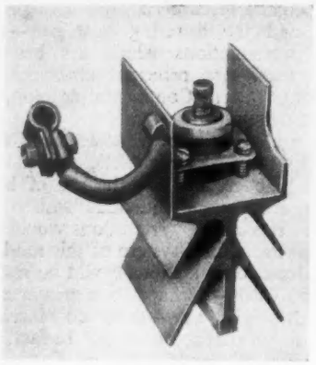


Fig. 2—Typical GP-C germanium rectifier cell mounted on aluminium cooling fins

To comply with these prerequisites for the quantity production of a range of semi-conductor power rectifiers a new factory has been built at Rugby and is now completing its first year of operation. This factory has two floors and contains a number of sealed-off working areas, totalling 14,000 square feet, for the development and production of the devices. On the flat roof are erected the air-conditioning plant, storage tanks for de-ionised water, and enclosures for the factory auxiliary services. An annexe extending along the whole length of one side of the building houses the high-frequency power generators and other heat producing plant, from which supplies are connected through the walls to the main building. This arrangement simplifies the temperature control of the working areas and gives ready access to the equipment for maintenance and adjustment without the necessity for entering the restricted areas. On the other side of the building are the containers for the gases used in the factory,

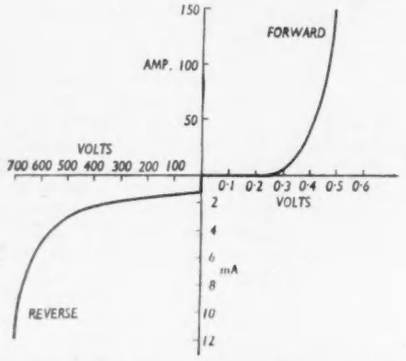


Fig. 3—Voltage/current characteristics (at 20 deg. Cent. of typical germanium rectifier

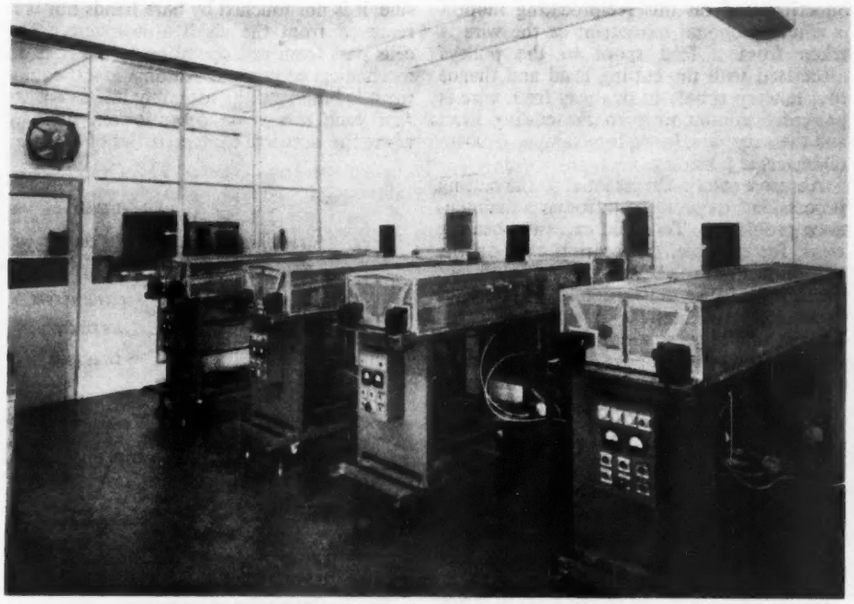


Fig. 4—Four high-frequency furnaces for the zone refining of germanium, in the form of an ingot, in a graphite boat drawn along the furnace tube

supplies from which are piped to the working positions. About 70 per cent of the factory space is devoted to development, pre-production and germanium and silicon crystal production, including chemical and other laboratories, engineers' office and special test accommodation, while the remainder consists of a specially designed quantity-production area under factory supervision.

To ensure a consistently high standard of general cleanliness within the building, the incoming air is filtered, washed and heated to maintain automatically an even temperature throughout the factory, but the rate of change of air is also automatically controlled, depending upon the temperature rise in the working areas. The air changes may thus vary between six and twenty-nine times per hour.

At certain stages in production where extremely high standards of cleanliness are required, assembly work is carried out in sealed cabinets, fed from an independent and specially controlled air supply.

Electrical power, de-ionised water, gases, and compressed air are piped behind panelling on each side of the building, outlets being arranged at intervals for connection to fume cupboards and working positions. Here again, special precautions are taken in the distribution system to maintain the high purity of the water and gas supplies. Another special service which enables all working areas to be cleaned with the minimum of effort is the piped vacuum system.

In order to facilitate cleaning, and to reduce the risk of dust and dirt accumulating, special attention has been paid to the internal finish of the building. Ledges and crevices have been reduced to a minimum, windows which could admit external dust and moisture are omitted, and surface finishes on floors, walls and ceilings are specially selected to discourage the retention of dust.

Strict regulations concerning clothing changes and personnel movement are in force on all staff entering and working in the building to limit the ingress of foreign matter. In addition, local protection is provided in other areas where contamination risk is high.

By such means several important objectives have been achieved during the relatively short time the factory has been in operation. Among the most important of these is a very marked increase in the quality and uniformity of the rectifiers produced. Better training and more expert supervision has succeeded in achieving a substantial increase in yield of finished rectifiers from the starting materials, and the personnel are now fully adapted to the new standards of cleanliness which are so necessary in this specialised work. This progress thus ensures that any future requirements for quantity production of devices needing these production conditions can be economically met at the required quality standard.

This new building adjoins the company's rectifier factory which offers all the required facilities for the erection, construction and testing of complete semi-conductor rectifier equipments engineered by a specialist team of the Rectifier Engineering Department. This ensures a closely knit organisation from the factory standpoint of production, assembly and shipment.

Semi-Conductor Rectifier Manufacture

The manufacture of semi-conductor rectifiers can be divided into two main stages: the first being the preparation of single-crystal germanium or silicon, and the second the processing of the crystal to form a *p-n* rectifying junction and the assembly of the junction into a hermetically sealed rectifying cell. The following description is concerned mainly with the high-power germanium rectifier.

Preparation of Single Crystal Germanium.—In the new B.T.H. factory the manufacturing process begins with the raw material, germanium dioxide, which is a white powder derived in this country from flue dust residues. Even in its commercially pure state germanium dioxide contains many trace impurities in quantities which would be intolerable for rectifier production. The attainment of the necessary purity and its maintenance throughout the subsequent processes is the governing consideration in the manufacturing techniques adopted.

The germanium dioxide powder is reduced to germanium by heating in furnaces in an atmosphere of hydrogen. To restrict the loss of germanium by volatilisation the temperature must be closely controlled. Thus the initial process of reduction is done at 700 deg. Cent. When reduction is complete the temperature is raised to approximately 1000 deg. Cent. (melting point of Ge, 936 deg. Cent.) and then the molten metal is allowed to cool slowly and solidify. The latter part of this process is carried out in an inert atmosphere.

The next step is purification of the ingot, which is done by zone refining, a process which depends on the preferential solubility of impurities in liquid germanium as compared with the solid state. The germanium ingot is placed in a pure graphite boat within a tubular enclosure containing argon. The boat is drawn along the tube by a motor-driven cable and passed through a series of high-frequency heating coils (Fig. 4). The zone of metal inside each coil is kept molten and, as the graphite boat is drawn along the furnace tube, so the series of molten zones travel towards the end of the germanium ingot. Because the main unwanted impurities are more soluble in the liquid germanium than in the solid the impurities move along the ingot

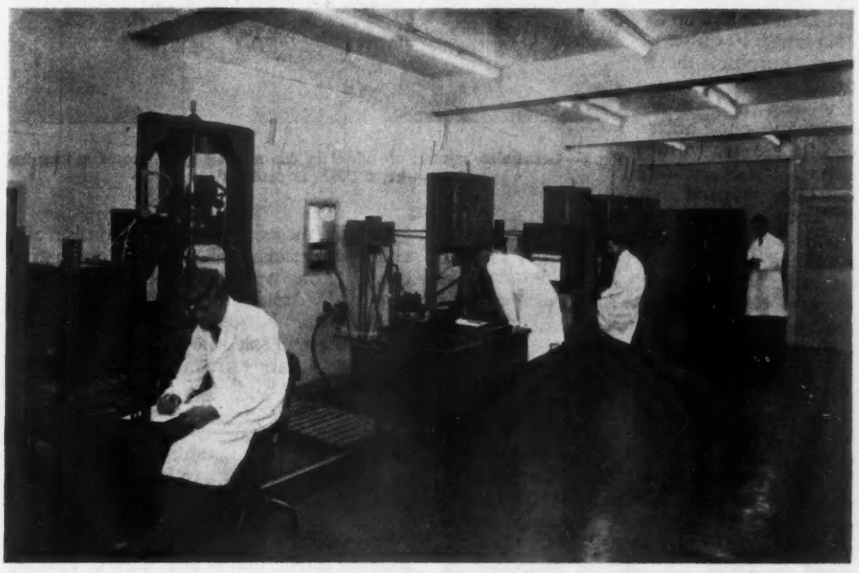


Fig. 5—Battery of crystal growing machines in which single crystals about ½in in diameter and up to 15in long are grown from a single seed crystal

with the molten zone and become concentrated towards the end.

The purity of the refined ingot is then checked by exploring the bulk resistivity of the material. This method gives a useful practical measure of the purity and gives a very good indication of the extent of the impure end zone and so limits the loss of material in the part that is cut away. These ends in which the impurities are concentrated are not discarded but are remelted and then subjected to further zone refining to recover some of the material that would otherwise be lost.

At this stage the germanium is in polycrystalline form and the next step is to produce a single crystal, by growing it on to a seed crystal immersed in a pool of molten germanium in an atmosphere of inert gas.

Refined metal is placed in a quartz crucible, together with a minute but accurately weighed amount of additive impurity. The crucible is heated in a graphite pot which forms the secondary circuit of a transformer. The whole is contained in a furnace chamber in an atmosphere of argon.

A seed crystal with its end cut at right angles to one axis of the crystal is lowered vertically into the pool of molten metal. The seed crystal is carried at the lower end of a shaft which can be rotated at about 2 r.p.m. and simultaneously withdrawn from the melt, the crystal growing on the end of the seed at the rate of a few inches per hour.

Throughout this crystal pulling process the temperature is very critical and must be controlled to within 1 deg. Cent. of the specified value to control the rate of solidification at the interface of the seed and the melt.

Another important consideration is that the concentration of impurity will vary in the melt due to segregation effects and the pulling rate and temperature settings must take these factors into account. A battery of crystal-growing machines is shown in Fig. 5. The single crystals produced by this process are about §in diameter and up to 15in long. For assessment purposes these are cut into sections 1in long and after resistivity and other checks are ready for slicing. Each section is then cropped in a cutting machine equipped with two cutting wheels, spaced the correct distance apart to produce, in two cutting operations mutually at 90 deg., a piece of germanium crystal of square cross section.

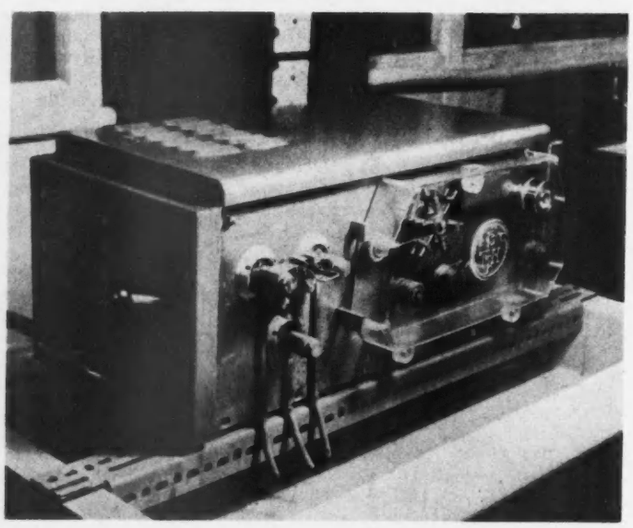


Fig. 6—Germanium crystals are sliced in this machine by reciprocating tungsten wire, 0·005in in diameter

For economy in the slicing process which follows, two such pieces of germanium are mounted side-by-side in a carrier and placed in the slicing machine (Fig. 6). Here cutting is done by tungsten wires of 0·005in diameter carrying a fine abrasive dust in suspension. In practice the wire is a continuous length, passed over a number of grooves in a system of pulleys with the required spacing to produce a number (usually 25) of slices of equal thickness. A pair of reciprocating pulleys is incorporated in the system to give the wire a reciprocating movement for cutting. Superimposed on this reciprocating motion is a unidirectional movement as the wire is taken from a feed spool to the pulleys associated with the cutting head and thence to a take-up spool; in this way fresh wire is presented continuously to the cutting head and the worn wire (now, for example, 0·004in diameter) is taken up.

Abrasive solution is essential to the cutting process, but its presence introduces maintenance problems. To avoid excessive bearing wear, for example, the bearing caps on the cutting head are fed with water at sufficient pressure to cause outward seepage and thus exclude abrasive matter.

Each of the germanium wafers cut in the machine described above, after inspection for flatness, surface finish and thickness tolerances, forms the basis of a rectifying cell, the construction of which is shown diagrammatically in Fig. 7. There are three parts to the cell. The first is the basic unit embodying the germanium-indium junction which constitutes the rectifier itself. The second is the electrode system consisting of an upper flexible connector and a lower base electrode to carry the electrical connections. The third part is the body assembly in which the basic unit is completely enclosed and sealed.

The assembly of these parts to make a rectifier cell is carried out in the first floor of the factory under conditions of surgical cleanliness. Access to this assembly shop is through changing rooms in which all persons entering the shop don "Nylon" protective clothing.

Broadly, the assembly process consists of a sequence of mechanical operations alternating with cleansing operations. Accordingly, the shop is divided into a "wet" zone and a "dry" zone. All operations such as washing, etching and soldering, from which fumes, fluxes and moisture are inseparable, are done in a wet area; full use is made of fume cupboards and extractors.

The clean operations are done in a dry area, where the assembly processes are carried out in dry glove boxes, the whole zone being free from moisture, dust and fumes.

From the stage where the rectifying element becomes active, that is after careful washing and prolonged vacuum drying, until it is encapsulated in the hermetically sealed capsule, it is not touched by bare hands nor is it removed from the clean atmosphere. The cells pass from one operation to the next on mechanical conveyors. Automatic test equipment is built into the assembly line to ensure that each successive operation in no way alters the electrical characteristics of the cells.

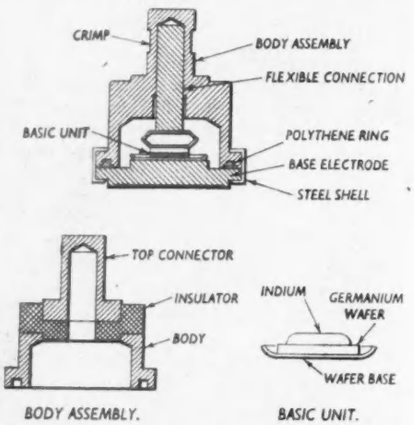


Fig. 7—Construction of germanium rectifier cell

By these means the movements of the operators are limited and precise control over each stage can be maintained.

It is evident from the foregoing that a great deal of special equipment is required for production and development processes, and adjacent to the new factory the semiconductor engineering department has offices, drawing-offices and workshops where all the required gear is developed, designed and constructed.

Particular operations require machines which in themselves are the result of quite extensive development work; among the more interesting examples of these are germanium and silicon crystal growing machines, high speed crystal cutting machines, besides test equipment and other production jigs and fixtures.

Assembly of Basic Unit

To make a basic unit a wafer of germanium 0·4in square and 0·025in thick, produced by the slicing machine, is first cleaned and then soldered, in an inert atmosphere, to a wafer base, using a special solder with a melting point of 170 deg. Cent.

Next, a pellet of pure indium is cleaned and placed on the germanium wafer and fed on to a belt conveyor which traverses a resistance furnace in which the temperature in the hottest zone is maintained at 600 deg. Cent. in an atmosphere of argon. Here the indium fuses into the germanium and a *p-n* junction is formed, as indicated in Fig. 8. This operation completes the basic unit, which is then soldered to a base electrode consisting of a heavy plated copper disc to provide adequate thermal and electrical contact, the solder again being a special alloy with a melting point of 150 deg. Cent.

At this stage of the manufacturing process the product now becomes a rectifier, but in order to improve its electrical characteristics it is necessary to remove some of the impurities found in the surface layer of the fused junction, this operation being done by an etching process which produces a groove along the edge of the junction as shown in Fig. 8.

This etching is an electrolytic process to avoid the possibility of contamination normally associated with the simplest method of etching—in an acid which attacks the surface which it cleans, but produces a salt which could cause surface contamination. For

etching the groove, therefore, the basic unit is made to form one electrode, the other being a material which is not attacked by the etchant. This process is thus the reverse of the normal electrodeposition and removes material from the area required.

After the cell has been thoroughly cleaned and vacuum-dried it is passed into the sealed assembly line where its electrical characteristics are first measured. If this test is satisfactory the flexible connection is soldered and further electrical tests follow each successive operation. The final process in completing the cell is the fitting of the body assembly, which is carried out in the same assembly line (Figs. 9 and 10), the unit having remained in the enclosed atmosphere from the stage of first becoming a rectifier.

After encapsulation the cell can now be handled with impunity and is conveyed to the

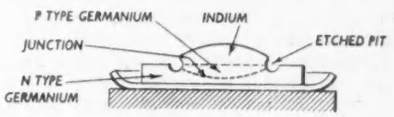


Fig. 8—The P N junction

test department where it is graded, painted and marked with a colour code to indicate the test grade, which constitutes its classification according to its electrical performance. Since this grading of output from a single production line is determined by the final performance tests it is clear that the numerical distribution in these grades gives a useful guide towards quality control.

Testing

Production testing is carried out in an area adjoining the new factory where a series of standard acceptance tests are applied to every production cell.

The rectifiers, whilst heated in an oven to 75 deg. Cent., are subjected to an increasing inverse voltage and are graded according to the voltage values attained before a given inverse power dissipation is reached. Several production grades are allocated covering a range of voltages, but over 80 per cent of the total production falls in the top grade. This voltage is used as the basis for fixing the maximum peak voltage to which the cell should be subjected and the safe working voltage is specified as a fixed fraction of this value depending upon the application. The forward resistance of the rectifier is then measured conventionally by passing a heavy current through the cell in the forward direction, the millivoltage drop across the cell being recorded. Narrow limits are imposed at this test to ensure satisfactory current sharing when working in parallel.

The fault current test, corresponding to approximately thirty times the rated current, is applied to every cell for a short period whilst the inverse characteristic is displayed. No variation in this is permitted. Hot overload tests follow and, after special tests to ensure that the electrical characteristics are maintained throughout life, a final check is applied to reaffirm the original grading before the cells are shipped to stores.

Technical Liaison

Work of this kind which calls for an unusually high standard of technical supervision demands special treatment in its transition from the development stages through preproduction to the factory. This has necessitated an entirely new concept of co-operation between the staff of the respective departments and the measure of success achieved by B.T.H. in this respect is evident by the rapidity with which these new semiconductor products have reached the successful quantity production stage.

In the majority of products manufactured in engineering concerns, the production process is defined for the factory organisation in terms of drawings and specifications. In the semi-conductor field, however, experience has shown that this in itself is insufficient to

Fig. 9—Fitting of body assembly to germanium cell is done in a drybox

guarantee successful production at the desired efficiency. There must be a very considerable overlap between the development laboratories where the device is primarily designed and the preproduction facilities where the technique of quantity production is worked out. Similarly, the stages of transition between preproduction and factory production demand a high degree of co-operation and understanding between the respective personnel.

To meet these ends the respective teams in the new B.T.H. semi-conductor factory are closely situated and daily contact is maintained between them to ensure smooth transition and a rapid response to problems encountered in the production line.

A comprehensive system of quality control is maintained by sampling methods, the preproduction line continuing to manufacture small control quantities for a considerable period after the main factory is under way. An exchange of products at various stages between these two units ensures that process variation can be carefully controlled and the effect of various factors on the quality and yield of the finished product can be fully assessed.

It is clear that in work of this kind, where there are so many variables which can affect the performance of the final product, a very thorough system of correlation between all the main factors in production which can influence quality and the final performance are kept under constant review, and to this end B.T.H. semi-conductor engineers have made full use of modern methods of statistical analysis using a high speed digital computer. These methods enable attention to be directed to process variations which are having a significant bearing on quality and, in course of time, producing a background of evidence to enable more specific production specifications to be formulated for the future.

These methods in no small way have contributed to the substantial improvement in quality and ensure in the future ever-improving standards of reliability and performance.

The engineering of special equipment for development and production has already been referred to, but in this context emphasises further the necessity of co-operation between the factory and engineering and development departments. Here again the location of these departments is in close proximity and assists in maintaining the necessary personal contact between the sections concerned.

Silicon Power Rectifiers

Any article on semi-conductors would be incomplete without reference to the advent of the silicon power rectifier, and in this field

Fig. 10—Drybox assembly line for germanium power rectifiers. Oscillographic test instruments can be seen in position at two of the assembly stations

the British Thomson-Houston Company, Ltd., is again prominent, having a high-power, high-voltage silicon cell in the late stages of preproduction in the new factory.

Rectifiers using silicon for the basic rectifying element operate on a broadly similar principle to germanium cells, utilising the *p-n* junction, but in this case comprising usually silicon-aluminium as compared with the germanium-indium junction already described.

There are, however, important differences in the performance of these cells, and although the experience on high power silicon at the moment is somewhat limited as compared with germanium, where over 50,000 B.T.H. power cells are now in service, it is already evident that in certain applications the silicon cell can be used to advantage.

This advantage lies in the fact that the *p-n* junction can be operated at higher temperature and the materials from which it and the associated connections are formed are of high fundamental melting points. They are, therefore, able to withstand more arduous working conditions as far as ambient temperature is concerned. As is often the case, however, advantages of one kind are usually accompanied by disadvantages of another. The silicon cell is no exception and is inherently less efficient at the same working voltage, so that from this standpoint it is less attractive. It has been suggested that under certain conditions silicon cells are less able to withstand unfavourable voltage surges, but in the light of experience on germanium such a statement could not be justified until experience has been accumulated in the field with many thousands of cells of consistently high quality.

The manufacturing techniques for silicon rectifiers are different from those employed on germanium. In the first place crystal growing is attended by many additional difficulties; primarily due to the much higher temperature at which the material melts—in the region of 1500 deg. Cent., and the corresponding difficulty of limiting unwanted contamination introduced all too easily at these temperatures.

Materials which are satisfactory at germanium working temperatures of 950 deg. Cent. or thereabouts are no longer suitable. For this reason also conventional purification methods such as already mentioned cannot be employed as in many cases the material receives contamination from one impurity whilst another is being removed.

Silicon crystal quality is assessed by methods similar in principle to those used for germanium and a study of resistivity, structure and lifetime constitutes the basic method of quality assessment. Crystals are cut into slices by a similar technique, although the sizes, thickness and resistivity values are usually of a different order. Due to the different characteristics of the silicon *p-n* junction materials the thickness of the wafer is only 0·25mm. Consequently, the thickness tolerances are much tighter; accurate slicing is, therefore, a much more difficult problem, especially as the areas involved are larger and the material nearly twice as hard.

Production methods differ in detail from those described above, but have the common requirement of a very high standard of cleanliness, close technical supervision and comprehensive correlation of the variables involved.

Conclusions

This article outlines some aspects of the interesting work now going on in the B.T.H. new semi-conductor factory and emphasises the ever-growing importance of these new power devices. In spite of the short period in which they have been established, great technical advances have been made. Substantial industrial installations are already in commission and others are under construction, the majority of early difficulties encountered in quantity production of these devices have been overcome, and consistent quality and reliability can now be taken for granted.

Looking ahead even into the very near future, further advances in semi-conductor power devices can confidently be expected, particularly in the field of controlled rectifiers where power control and rectification can be simultaneously effected at high efficiencies. Much of the technique for these new devices has already been determined and in consequence the progress on these exciting new developments should be rapid.

Laboratory Chassis Dynamometer

An unusually elaborate chassis dynamometer has been installed in the Engine Laboratory of the Associated Ethyl Company, Ltd.: electronic control of a "Dynamatic" brake allows the transient states of a vehicle on a level road to be simulated.

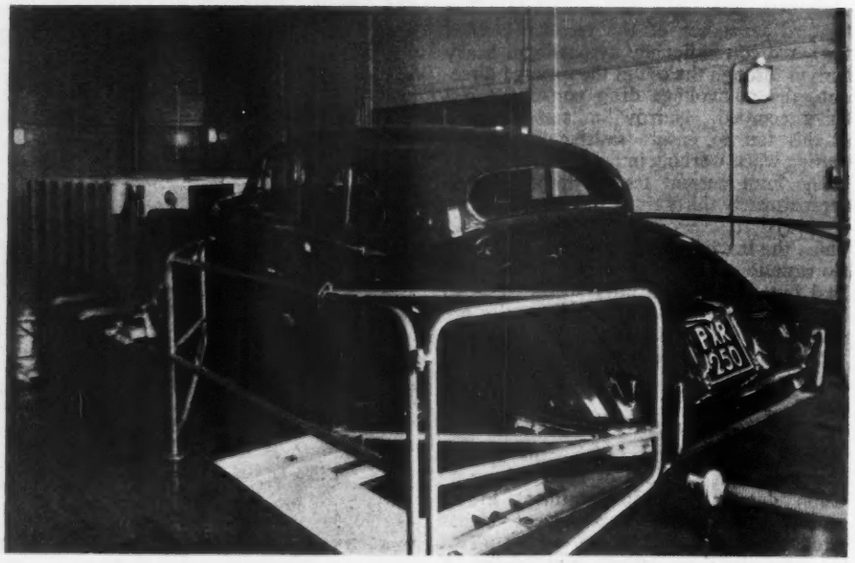
THE octane requirement of an engine is well known to be sensitive to very many variables, which do not exclude factors peculiar to individual installations, such as the intake air temperature. For this reason it is strictly necessary to test the engine in its true environment, but to perform such a test, in which several different fuels will have to be used, on a road or test track will be a slow and expensive process, particularly for high-performance vehicles, and subject to random variations due to weather. Testing the engine in the vehicle has the additional advantages that it allows a number of engines to be sampled, and tests to be repeated at intervals during the engine life, without the delay, and risk of disturbance, caused by removing the power unit. For these reasons the Associated Ethyl Company, Ltd., have installed in their Engine Laboratory at Bletchley a chassis dynamometer which will allow road conditions to be reproduced in the laboratory. The dynamometer is complete with provision for motoring the vehicle, and sufficient cooling air supplies to permit prolonged testing.

In the use of the chassis dynamometer, the performance of the vehicle is first measured in normal running : the dynamometer, which includes rotating masses to reproduce the inertia of the vehicle, can then be set to give an equivalent performance. The dynamometer control gear can also be set to maintain a constant speed throughout a test, or a constant brake effort.

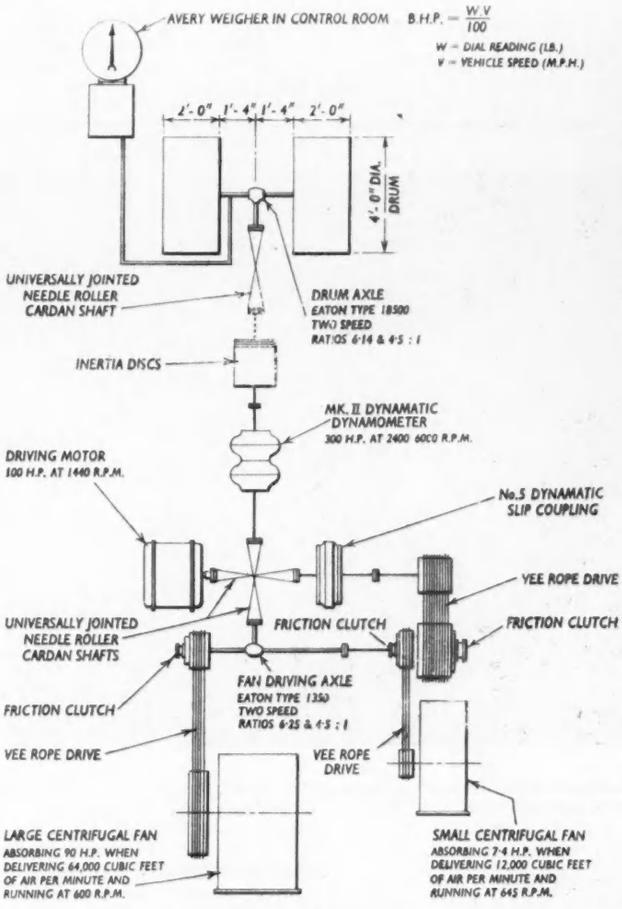
In order that the work done by the vehicle shall not be wasted, and that a minimum of electricity be consumed, the actual measurement of power developed is by a transmission dynamometer and not a brake. The dynamometer proper takes a very simple form : it is a right-angle gearbox pivoted about the axis of one shaft and the input torque is measured by a balance through a series of levers. The construction, however, is of interest : the input is taken by a pair of 4ft diameter rollers upon which the driven wheels of the vehicle rest, so that the right-angle drive is conveniently provided by a vehicle driven axle. The rollers are in fact mounted upon an Eaton "18,500" two-speed axle with the differential locked : the axle is supported in trunnion bearings and restrained by a torque arm linked to a weigher in the control room, just visible, through a window, over the roof of the car in our illustration.

The pinion shaft of the axle, which is driven in the opposite direction to its normal application, is coupled by a cardan shaft to an assembly of inertia discs. This comprises up to thirty discs, 17½in in diameter and each weighing 37 lb, of which any number can be bolted together to rotate with the central shaft : each disc is dynamically balanced, since the maximum speed of this assembly is 6000 r.p.m. In front of the inertia assembly is a Mark II "Dynamatic" brake dissipating up to 300 h.p. over the speed range 2400 to 6000 r.p.m.

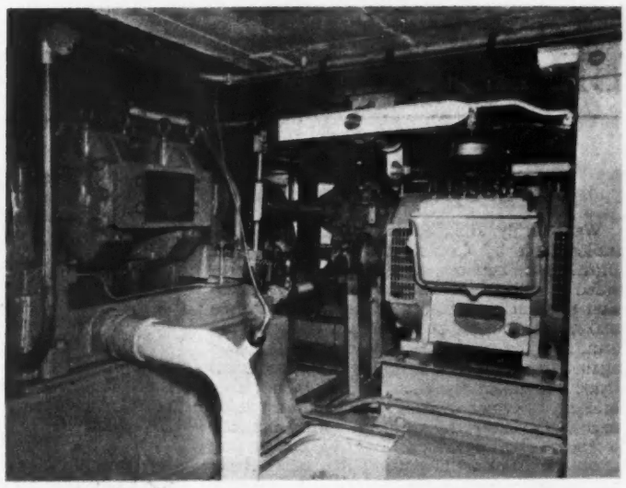
Another cardan shaft from the front of



A vehicle prepared for test ; observe the clamp on the front wheels and the extended exhaust pipe. The slots near the back wheels emit cooling air


AVERY WEIGHER IN CONTROL ROOM
B.H.P. = W V / 100
W = DIAL READING (LB.)
V = VEHICLE SPEED (M.P.H.)
2'-0" 1'-4" 1'-4" 2'-0"
4'-0" DIA. DRUM
UNIVERSALLY JOINTED NEEDLE ROLLER CARDAN SHAFT
DRUM AXLE EATON TYPE 18500 TWO SPEED RATIOS 6·14 & 4·5 : 1
INERTIA DISCS
MK. II DYNAMATIC DYNAMOMETER 300 H.P. AT 2400 6000 R.P.M.
DRIVING MOTOR 100 H.P. AT 1440 R.P.M.
No.5 DYNAMATIC SLIP COUPLING
VEE ROPE DRIVE
UNIVERSALLY JOINTED NEEDLE ROLLER CARDAN SHAFTS
FRICTION CLUTCH
FRICTION CLUTCH
FAN DRIVING AXLE EATON TYPE 1350 TWO SPEED RATIOS 6·25 & 4·5 : 1
FRICTION CLUTCH
VEE ROPE DRIVE
VEE ROPE DRIVE
LARGE CENTRIFUGAL FAN ABSORBING 90 H.P. WHEN DELIVERING 64,000 CUBIC FEET OF AIR PER MINUTE AND RUNNING AT 600 R.P.M.
SMALL CENTRIFUGAL FAN ABSORBING 7·4 H.P. WHEN DELIVERING 12,000 CUBIC FEET OF AIR PER MINUTE AND RUNNING AT 645 R.P.M.

Composition of vehicle test plant



Below the floor of the test cell are installed the eddy current brake (left), and, coupled to it, the axle driving the fans. In the foreground is the squirrel-cage motor used to determine friction horsepower

the dynamometer drives a second differentialless Eaton two-speed axle, this one a " 1350 " series used to distribute power to the main cooling air fans and to accept it from the motoring input. All drives to and from this axle are by multiple V-belts through air-operated friction clutches. The power source is a 100 h.p. constant-speed squirrel-cage motor : a " Dynamatic " coupling gives control of the torque input—the motor can be used when the vehicle is driving the dynamometer in order to increase the power available to the fans or reduce the " rolling resistance " of the rig. When motoring the fans will be declutched, and about 95 h.p. will be available at the drums at up to 123 m.p.h.

The two fans have dampers adjustable manually from the control room, and deliver to a 3ft square duct facing the rollers: the end of the duct can be moved up close to the vehicle, and has vanes to alter the height and depth of the cooling blast. The air flow will, of course, be proportional to indicated vehicle speed. There is some slight control of cooling air temperature by re-circulating the air in the test cell, but the roof has been stressed to carry refrigerating plant if such is found necessary.

There are two further fans driven by electric motors which deliver air through louvres before and behind the rollers to maintain acceptable and realistic tyre and final drive temperatures.

The brake and coupling both have electronic control gear responding to a speed signal generated by a magnet of " Alnico " rotating at brake speed. This control apparatus is capable of dictating a constant speed for ease of establishing engine characteristics, or of generating a cube law loading which reproduces the effect of air resistance. The control of the brake has no feed-back from the observed dynamometer load, and hence variations in the friction in the plant cause departures from the programmed behaviour. While most of the controls, including the vehicle ignition circuit, are controlled from the control room, a wandering lead allows the vehicle crew to adjust the brake absorption from the cabin. An additional provision is braking of the main rollers to restrain them when a vehicle is being moved on or off the dynamometer : automotive internal expanding brakes are used, but are not mounted on the axle in order to isolate the measuring linkage from the forces involved : the brake drums are on the outer faces of the rollers, and special abutments carry the backplates.

In order to reduce variations in friction, for the reason given above, and also because the axles are running at speeds greatly in excess of their design condition, they have been converted to dry sump lubrication : some modification of the drum axle was obviously mandatory because the scoop on the crown wheel would be ineffective in reverse. Automatic controls maintain the oil input temperature within prescribed limits : the bearings of the differential cage are fed by a pipe entering the existing distribution system in the place of the scoop feed, and there has been added a jet playing on the closing teeth of the bevels. Cooling water being not available in plenty on the site, there is provided a Heenan water cooler handling supplies for this and other plant.

The installation is adaptable to a great variety of vehicles. The masses available for simulating inertia are roughly equivalent, in low ratio of the drum axle, to a 2-ton vehicle in top gear, and the minimum inertia using the high ratio and the small fan (which limits speed to 60 m.p.h.) to a 15 cwt vehicle in top gear. The drum will carry loads greatly in excess of this, actually up to 8 tons : the outer wheels on twin rear wheel axles will be removed. If it is desired to measure the total rolling resistance of a vehicle it will, of course, be necessary to turn it round and put the front wheels on the drums in their turn. The maximum allowable speed is 140 m.p.h.: an overspeed trip cuts the ignition if this is reached.

Testing Procedure

Some of the details of the test procedure are of interest. The vehicles used are fitted with Michelin " X " tyres, since it is found that the very flexible side walls lessen the discrepancy in rolling resistance caused by the additional tyre deflection when resting on a drum : these tyres have the additional advantage that the steel casing grows little with speed, and therefore the calculation of engine speed is facilitated. The driven wheels are placed slightly—say ½in—in front of the plane of the drum axle : this does not call for a correction in the thrust balance, and improves the stability of the vehicle. It is found that the vehicle will slide sideways on the drums if the wheel brakes are applied hard—at least, this is true in the case of Hotchkiss drive vehicles—so no use is made of the foot brake. The vehicle is fitted with an electric petrol switch adjacent to the carburettor so that motoring tests can follow driving tests with no more preparation than turning off the ignition, and there is no risk of inflammable vapour accumulating in the exhaust ducting. Seen in our illustration is a 3½-litre Jaguar, which was demonstrated to have a full throttle output of 135 h.p. at 100 m.p.h.: this car has a Borg-Warner automatic transmission, and consequently is able to spin the rear wheels on the discs at low speeds. It was interesting to observe that the impulses of " hot " shifts, which on the road would be swamped by the momentum of the vehicle, caused it to surge heavily against the chocks.

The various fuels needed for knock investigations are carried aboard the vehicle and selected by the driver or observer. Consumption measurements, when required, are made by " Petrometa " instruments calibrated at fairly frequent intervals.

The test plant was built and installed by Heenan and Froude, Ltd., Worcester.

Air-Operated Vice.—An air-operated vice now being marketed by Dyson and Nalson, Viaduct Street, Huddersfield, has 3½in wide jaws which will open to 3in. It is suitable for operation with air line pressures up to 150 lb per square inch, and the clamping force can be infinitely varied up to a maximum load of 2200 lb. The sliding jaw is adjusted by means of a large screw and nut and has a ½in power stroke.

SHORTER REPORTS

Air-Sprung Trailer

We recently attended a demonstration of a trailer built by Cranes (Dereham), Ltd., for British Road Services, on which springing is provided by air bellows. The geometry of the suspension is similar to that used previously by the maker, each wheel being located by a trailing arm, and the two arms on each side balanced against one another so that, in equilibrium, equal loads are taken by each wheel, even during braking. Former vehicles have achieved this by means of a laminated cantilever spring mounted on the rear trailing arm, with its front end bearing upon the front trailing arm ; the new vehicle has the rear arm extended forward and supported from the front arm by the air spring. The spring is a two-convolution " Airide " bellows supplied by the Firestone Tyre and Rubber Company, Ltd.; the surge tank is formed in the forward projection of the rear arm.

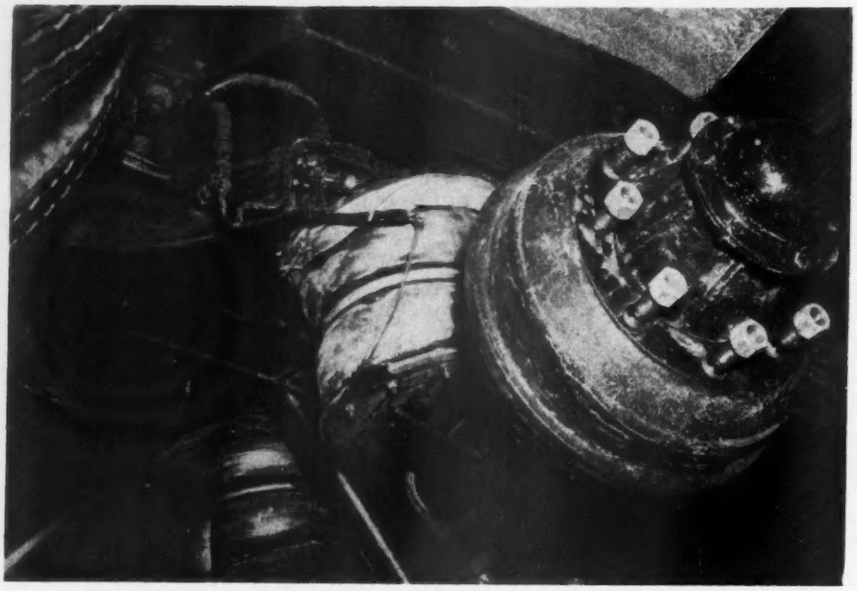
With this suspension arrangement the wheels have a large amount of articulation—the load on each wheel remains the same with one of a pair about 6in above the other—and the levelling valve to detect deflection of the suspension under load is mounted not on the chassis, but between the arms across the spring.

The form of levelling valve used at present is a Westinghouse product, which gives the effect of a small orifice for small deflections and a large orifice for large deflections, it being expected that, because of the balancing of the trailing arms, large deflections will arise only with changes of load. This has the result that the suspension will resist the tendency for the chassis to lean one way or the other under side loads. This is expected to prove valuable on a trailing arm suspension, which would normally emphasise the tendency for a semi-trailer to follow at an angle on a cambered road. The momentary increased tilt of the body when the side force reverses its direction, and the slight expenditure of air in resisting the tendency of the bogie to dive under braking, are not considered to be serious defects in this relatively hard suspension.

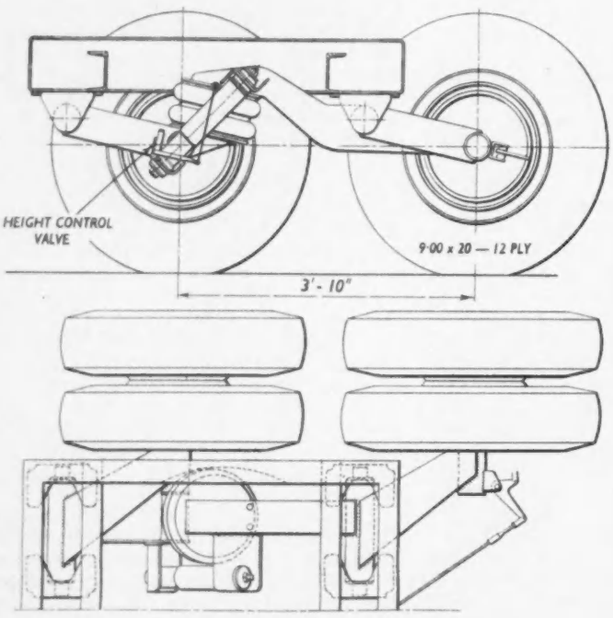
A hydraulic telescopic damper is fitted at each side ; this has an effectively unlimited life. The trailing arm pivots include self-aligning roller bearings and require to be packed with fresh lubricant only at intervals of the order of a year. The design travel is such that, even with both wheels on the bump stops, the bellows is not fully compressed ; the movement from this point to the other extreme of wheel travel is 3in. Clearly, with this form of suspension wheel deflections slow enough not to evoke significant inertia forces cause no spring deflection until one or the other wheel reaches the end of its travel. This installation is designed so that the first stop contacted is the rebound stop of the falling wheel, and therefore extra air is added to the spring ; if the weight of the trailer is low enough, this may cause the vehicle to lift and raise the wheel further off the ground. This case is clearly preferable to the alternative of contacting the bump stop of the rising wheel first ; although, for a given total travel of either wheel, this makes it more difficult to get one wheel off the ground, the result of so doing would be to empty the air spring.

The vehicle illustrated has a gross weight of 24 tons and a payload of 16/17 tons ; at full load the bellows pressure is 45 lb per square inch and the suspension frequency 90 cycles per minute. When the vehicle is unladen, the bellows pressure falls to 5 lb per square inch.

We have ridden upon the trailer and found that the high-frequency displacements, inevitable with a lightly loaded vehicle on leaf springs, were much less noticeable than in, say, a bus or coach of conventional design.



Suspension fully extended, seen with front offside wheels removed. In service, light shields would surround the bellows to prevent small stones being trapped in the convolutions



Trailing axle bogie designed for road tanker

Embakasi Airport, Nairobi

A new airport in Kenya serving Nairobi—Embakasi airport—is due to be opened by the Queen Mother tomorrow, March 8. Although the airport will be operational from its opening it will not be completed until September. It has a single runway and terminal buildings and is situated on the Athi plains about 10 miles from Nairobi. Increasing mechanisation has been noticeable in all civil engineering operations over the past few years, and airfield runway construction is now generally one of the most highly mechanised tasks of all. The runway at Embakasi, however, has been constructed with extensive use of hand labour, Mau Mau convicts having been employed on the work. The following brief description is based on notes from Mr. A. Johnston, resident engineer for the Kenya Ministry of Works.

The runway is 10,800ft long and 10,000ft between threshold markings. There are 200ft and 600ft overruns at the south-west and north-east ends, respectively, with cleared extensions of 800ft and 1400ft. The width of the runway is 200ft and net width between lights 150ft. About 95 per cent of all air movements will be at the south-west end, the elevation of which is 5327ft above sea level. There is a fall of 34ft over the length of the runway, consisting of gradients of 1 in 422 ; 1 in 289 ; and a short length of 1 in 220 at the north-east end.

The apron is approximately 1000ft square and is connected to the south-west runway threshold by a 75ft wide taxiway parallel to the runway and 650ft from it, which opens out into a " holding area."

There are two main drains, one on each side of the runway and 520ft from the centre line. Each is over 13,000ft long, runs the full length of the runway and discharges into normally dry stream beds. Water spills off the runway cambered at 1 in 75 from the crown, over margins 150ft wide and graded at 1 in 100, into longitudinal mitre drains which lead off every 1000ft herring-bone fashion into the main drains. The apron is drained by three slotted drains constructed in reinforced concrete and falling from the terminal building side into the west main drain. The apron is cambered between these drains, the camber being 1 in 100.

The plain on which the airport is built consists of black cotton soil to a depth of about 2ft 6in. Covering the whole area like pock-marks are the now well-known Athi plains craters, which are saucer-shaped and vary in diameter from 50ft to 100ft and are 3ft to 5ft deep at the centres and contain a whitish soil which has remarkable swelling characteristics when wet.

The first step in the construction after the setting-out was the excavation of all black cotton soil over the basic strip area of 10,800ft by 500ft, followed by excavation of the craters. There were forty of these craters on the runway alone. Great pains were taken to remove all black cotton soil over the runway. The work was done manually by Mau Mau convicts with Decauville track and trucks. The sub-base was constructed of hand-packed phonolite spalls in the manner advocated by Telford 150 years ago. This was followed by a choke course and the whole was soaked and thoroughly rolled with a fleet of 12-ton diesel rollers. The undulations caused by the heavy rolling were removed by the construction of a "levelling course" to restore correct gradient and camber. At this stage the pavement was super-compacted with a load of 50 tons carried on four pneumatic tyres with a tyre pressure of 150 lb per square inch. The base course 8in thick was constructed in two 4in layers of 2in hand broken phonolite bound by a mixture of stone dust and red earth, dry and wet rolled until compacted. The finished surface consists of 4in of hot mix asphalt applied in two courses; the first 2½in of compacted thickness was a coarse mix and the finished wearing surface 1½in of dense mix. The finished surface was again super compacted to ensure a thoroughly kneaded surface.

There are two rows of hard-standings on the apron each 800ft long and served by a hydrant fuelling system. There is provision for a third, but only the first of four hard-standings has been constructed in this row. These hard-standings are constructed in concrete 14in thick and put down in two 7in layers.

Water supply for construction was obtained from a series of boreholes drilled on the site, and the permanent water supply for the airport will be obtained from three of these boreholes. Water is pumped into a 90ft high 100,000-gallon reinforced concrete water tank and gravitates from there. Construction began in January, 1954. Initially Embakasi was designed as a class III airport capable of taking a 60,000 lb wheel load at 100 lb per square inch. Plate bearing tests taken on the redesigned and finished surface, however, show a load classification number of 100 which is up to class I standard.

275MW Generating Units for C.E.G.B.

THE Central Electricity Generating Board has placed orders for two 275MW generating sets with the English Electric Company, Ltd., and two 275MW boilers with Yarrow and Co., Ltd. It is planned to install this plant in a projected new power station, Blyth "B," in Northumberland. Considerable economies in construction and operating costs are expected from these sets, which have outputs more than twice as great as any existing sets in the Board's stations.

The turbine design provides for a three-cylinder, 3000 r.p.m., reheat machine. In its general arrangement each machine is similar to the 200MW sets with triple exhaust, now being made by the English Electric Company, Ltd., for similar operating conditions, except that the l.p. cylinder of the 275MW turbine has quadruple exhausts in two double-flow casings, each exhausting to one-half of the twin condensers. Steam conditions at the stop valve are 2300 p.s.i.g. at 1050 deg. Fah., with reheat to 1050 deg. Fah., 565 p.s.i.g., and exhausting at 29in Hg. To provide ample exhaust area the last blade on each of the four l.p. flows is of 36in effective length on a mean diameter of 100in.

The generator is designed for an output of 323·5MVA at 0·85 p.f. lagging, 16kV. By using direct cooling in both stator and rotor (THE ENGINEER, November 15, 1957), raising the alternator gas pressure to 45 p.s.i.g., and by using cold-rolled, grain-oriented steel for the stator core-plates, it is proposed to obtain 275MW from a frame size only slightly larger than the 200MW sets now being made for High Marnham. Circulation of the hydrogen cooling gas is by a high-speed gear-driven blower as described in the article quoted above.

Seven stages of feed heating are being provided, the fourth stage being in the form of an elevated deaerator feeding direct to the first stage of feed pumping. The following three high-pressure heater stages are interposed between the first and second stages of feed pumping. The main high-pressure, second-stage feed pump is driven through a variable-speed fluid coupling from an extension of the main generator shaft. The booster (first stage) pump and the starting and standby pumps are electrically driven.

The boilers are being designed with controlled circulation and twin furnaces fired with pulverised coal to give an evaporative capacity of 1,900,000 lb of steam per hour at 2400 p.s.i.g. and a final temperature of 1055 deg. Fah., with reheating to the same temperature. Each boiler, with its associated pulverising plant, economiser, air heaters, fans, electrostatic precipitator and flues is designed to occupy a floor area of about 150ft by 375ft, the top of the boiler being about 165ft above ground level.

Institution of Electrical Engineers

MORE than one speaker at the annual dinner of the Institution of Electrical Engineers, London, on February 27 was concerned with problems of education and training. Lord Adrian, Master of Trinity College, who proposed the toast of the Institution of Electrical Engineers, spoke of the need for keeping a balance between the arts and sciences in the attempts that were being made to train more students. Much had been said in the past about the need for science students to appreciate the humanities, but was it not equally important that arts students should have a sound background of scientific knowledge and of the fundamental ideas that lay behind most of the technological advances of to-day?

Mr. T. E. Goldup, the president of the Institution of Electrical Engineers, who replied, touched on a more immediate problem when he referred to the Diploma in Technology and the difficulties created by the wide variations in sandwich courses devised by different technical colleges. This problem had been the subject of recent discussion between the I.E.E. and the Ministry of Education and a joint statement was soon to be issued. A main feature in the new pattern of development, said Mr. Goldup, would be a two-year sandwich diploma course for technicians, to follow the Ordinary National Certificate. In future that certificate might lead either to one of these new courses for technicians or to a Higher National Certificate, or a Higher National Diploma, or a Hives' course. Apart from the universities it would be mainly the Higher National Diploma course to which the Institution would look for its future professional members. Mr. Goldup made it quite clear, however, that the Higher National Certificate would still provide an avenue, but an increasingly laborious one, to professional qualification; he, personally, thought that this part-time method of progressing towards professional status was not always in the best interests of the student, particularly because of the wider and deeper field that had to be covered.

Industrial Films

Two films of particular interest were shown before invited audiences in London last week. "A Tour of the Works," produced by the photographic section of the Brown-Firth Research Laboratories, is, as its title implies, a conducted tour on film around the steel works of Thos. Firth and John Brown, Ltd. The works are over 80 acres in extent, but during the thirty-three minutes for which the film runs, many departments and processes are covered. The tapping of three Siemens furnaces for the production of a 200-ton ingot is shown; the production of hollow rolled products; the production of large forgings on hydraulic presses from 800 to 6000 tons working pressure, and of smaller forgings where the skill of the hammer-smith using relatively simple tooling is demonstrated. The nitriding process and production of drop forgings and alloy steel castings is shown, and the film concludes with examples of the use of Firth-Brown steels in the field of power generation.

The second film, "Put This in Your Pipe," has been produced by the Aluminium Company of Canada and was shown by Aluminium Union, Ltd. It describes the installation of a water-injection system employing aluminium pipe in an oilfield in Alberta. The water is drawn from the North Saskatchewan River, and filtered and pumped through 6in aluminium pipe at a pressure of 500 lb per square inch. More than 16 miles of 6in and 4in aluminium pipe of "Alcan" 3S alloy have been used, and the 40ft sections were butt-welded in the field. The film illustrates the ease of handling and laying of an aluminium pipeline.

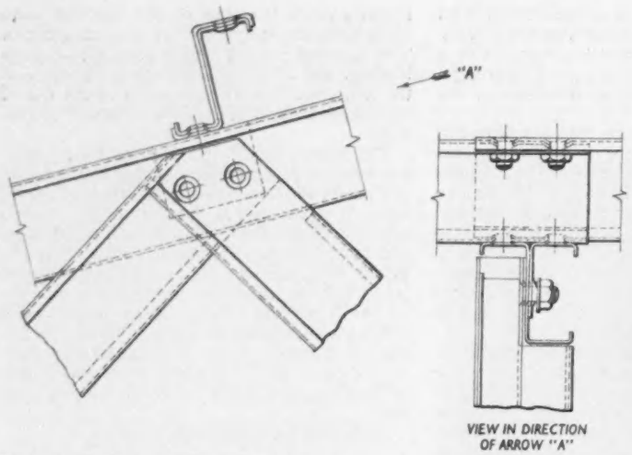
Both films are available in 16mm size.

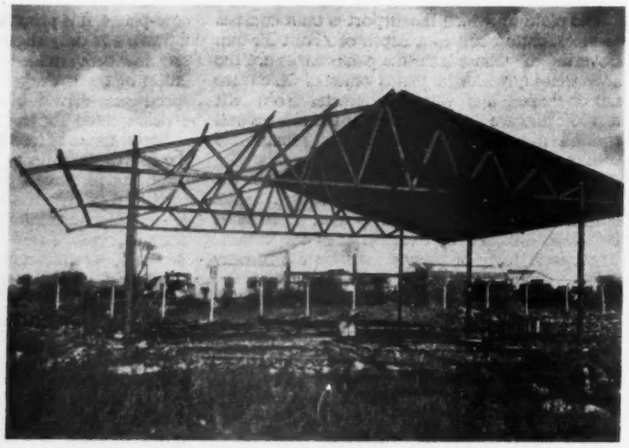
Chamber of Shipping Report

THE Chamber of Shipping of the United Kingdom has published its report for 1957–58. It draws attention to the fall in freight rates and instances this as illustrating the commercially hazardous nature of ship operation. The decision to recover the cost of clearing the Suez Canal by a surcharge on users is condemned as a regrettable example of sacrificing principle for expediency. Flag discrimination is also discussed in the report, and the statement made that universal adoption would mean the replacement of to-day's international shipping services with non-competitive multiple individual services of limited application. Also commented upon is the growth of the "Panhonlib" fleets to over 14,250,000 gross tons, or 15½ per cent of the world fleet, and largely belonging to Greek and United States interests. So far, it is stated, a solution has not been found to counter the menace of competition of tax-free shipping. A thought is given to the question of the permanence of the investment allowance which offers help to a limited degree towards meeting tax-free competition. The level and method of charging tolls for those using the St. Lawrence Seaway is briefly examined and suggestions noted. The report goes on to remark upon the trends of world shipping, shipbuilding in the United Kingdom and the home merchant fleet, which, it is noted, has increased by about 1½ per cent, compared with 4¾ per cent for the whole world. On the question of nuclear power for merchant ships, attention is called to the criticism that no dates are forecast for the completion of an atomic-powered ship for this country and the comment is made that shipowners cannot think in terms of national prestige but in those of commercial advantage. Further research, it is felt, in prototype reactors on land may delay the entry into service of the first experimental nuclear ship, but could result in the quicker development of a ship superior economically to one burning conventional fuel.

Marchwood Power Station

AT a joint meeting of the Southern Association of the Institution of Civil Engineers and the Southern Branch of the Institution of Mechanical Engineers, held on Thursday, February 20, at Southampton University, there was a large attendance. Mr. B. C. Pyle, M.I.E.E., the chief assistant project engineer to the Northern Project Office of the Central Electricity Generating Board, gave an interesting lecture on "Marchwood Generating Station, some Design Considerations and Construction Problems." He dealt ably with the choice of site, on a tidal waterway, the laying of the foundations, and the design and construction of the plant and buildings. The lecture was well illustrated by drawings and slides showing the layout of the plant and illustrating points in the construction. Mr. Pyle then went on to deal in particular with the civil and mechanical aspects of the power station. The principal features, such as foundations, construction and equipment, have already been fully described in our pages.





(Left) Joint detail showing dished bolt holes and method of making typical connections at the top chord of the truss and between two lengths of purlin. (Right) A typical building partly sheeted with asbestos. The purlins span 16ft and the columns are sealed box sections

Prefabricated Steel Buildings

We have received details of prefabricated steel-framed buildings which have been introduced jointly by R. Costain, Ltd., and J. E. Lesser and Sons, Ltd. The steelwork utilises cold rolled sections of high tensile "Corten" steel and is termed the "Ciel" system. Since export in what is termed "piece small" condition, followed by relatively simple erection at a remote site, are basic aims of the design, the method of making the connections is of special interest. There are two basic designs : (*a*) a roof for domestic buildings of limited span variation (20ft to 32ft) for tropical and sub-tropical climates to provide initial protection from weather and sun for the remainder of the building construction to proceed, and giving economy in material and shipping cost with the maximum flexibility in span and bay spacing ; (*b*) an industrial building for all climates, of spans from 32ft up to 80ft to 90ft, with variations of eaves height from 12ft to 25ft, either clad and lined in standard forms of corrugated sheet and insulating material or used as a roof structure set on load bearing walls. Again, reduction of material and shipping costs whilst maintaining flexibility of span and bay length was sought, and the installation of gantry columns and beams for cranes of up to 10 tons capacity was also allowed for.

The roof for the domestic building allows 4ft variations in span, with various column positions. The columns may be cold-formed steel box sections. The roof trusses are Warren-braced, with the addition of a king post in some configurations. The truss members are Zed sections and the purlins are similar ; trusses are spaced 16ft apart. Design is based on B.S. 449. A reduction in bay width or span can be made to accommodate higher loads.

By varying the flange width of the purlins it was possible to allow adjacent purlins to be bundled on top of the rafters for convenience during erection. Continuity is provided by countersunk headed bolts fitted into dished holes, the dishing of the holes providing lateral joint strength by one dishing nesting within another, the bolts merely clamping the two deformed sections together. Thus bolt shear stress and bearing area between bolt and the thin section are not criteria of the joint strength. The truss connections are formed in the same manner, the joints near columns having an additional angle cleat, putting the connection into "double shear." A typical connection on the top chord of the Warren truss is shown in the drawings ; a purlin joint and the junction of two diagonal braces of the truss with the top chord are shown. A typical purlin is 3½in by 1½in by ⅜in by 14 gauge Zed section high tensile steel, weighing 1·75 lb per foot.

The industrial building is based on tied lattice rafter trusses. By altering the level and incidence of the tie, the maximum head room in the centre is given in terms of the maximum allowable stresses in the rafter chord members. With present design, the top rafter chord is a "Corten" steel channel, and other truss members are hot-rolled steel angles. The purlins are just as those already described, and there is a similar joint with the top rafter, to the one already illustrated. The truss shoe is designed to bear directly on padstones if a load bearing wall is specified ; otherwise R.S.J. columns and sheeting rails are used.

Lightweight Tractor

A LIGHT four-wheeled tractor, known as the "Crawley 75," has been introduced by Crawley Metal Productions, Ltd., Ifield Road, Crawley, Sussex. It is a general-purpose machine which, the maker says, is a British development of an American design. Its overall width is 4ft, length just under 7ft, height 3ft 9in, and the weight rather more than 12 cwt. The chassis is of welded steel, the front axle is high with a centre pivot, and the wheel track can be adjusted to 32in, 36in or 40in by reversing one or both wheels. There is a choice of power unit between J.A.P. petrol or t.v.o. engines and a Petter "Pcl" diesel engine.

The J.A.P. petrol engine installed in the tractor as demonstrated last week is a single-cylinder, air-cooled unit of 412 c.c., giving 6½ b.h.p. at 2700 r.p.m. on a twelve-hour rating, its maximum power being given as 8 b.h.p. The Petter diesel is a four-cycle, direct-injection engine of 348 c.c., giving 5 b.h.p. at 3000 r.p.m. The gearbox is arranged to give three forward speeds between 2·4 and 8 m.p.h., and a reverse speed of 2·4 m.p.h. A drawbar pull of 1250 lb is claimed for the tractor and the independent hand-operated rear brakes give a small turning circle ; there is also a foot brake for parking. The normal equipment of the tractor includes a belt pulley which is mounted forward of the gearbox.

A series of implements is being designed for the tractor. The accompanying illustration shows one of them, namely, a disc harrow. There is also a single-furrow plough which is attached by a single pin hitch, an angledozer, a 3ft 6in cutter bar, a tine cultivator, seed drill, and a 12ft spray boom. In addition, there is a low-loading 10 cwt capacity trailer suitable for haulage by the tractor. The tractor itself will be made in a factory which Crawley Metal Productions, Ltd., has equipped at Winschoten, Holland. The spares and accessories will be produced at a new factory which has just been completed for the firm at Angmering, Sussex.

The "Crawley 75" tractor with disc harrow attached

Scottish Water Power

THE North of Scotland Hydro-Electric Board achieved a trading surplus of £359 in 1957, according to its annual report ; the debit balance brought over from the losses incurred in 1956 and 1955 is thus substantially the same. However, expansion of the electrical system in the Board's area continued during the year, and 85 per cent of the households and 55 per cent of the farms in the area now have a supply.

During the year, 103MW of new plant was brought into commission. This total includes a steam turbo-alternator set of 30MW (with two 150k lb per hour boilers) at Dundee, and6MW of of diesel-driven plant. The principal hydro-electric plant brought into use was at Glenmoriston, St. Fillans, Mossford, and Sron Mor. The maximum demand on the Board's grid system was 411MW (plus about 21MW generated independently) and consumption totalled 1231 million units. Peak hour exports to the south totalled 466 million units and 72,000,000 units were imported at off-peak hours. Total installed capacity was 911MW, and units generated 1913 million ; electricity generated from water power totalled 1624 million units.

Capital expenditure during the year was nearly £17,000,000. Work is well advanced on the principal constructional schemes. Several new contracts were let, but no new works of a major nature have been started, though three new schemes have been "published"—Strathfarrar and Kilmorack, the Awe pumped storage scheme, and a small scheme to increase output at Storr Lochs, and on the Moriston.

Industrial and Labour Notes

The Revolving Loan Funds

The Board of Trade says that, following an approach by the United States Government, the United Kingdom Government has agreed to transfer to the use of certain British territories in Africa the £1,000,000 revolving loan funds for industry and agriculture which have hitherto been used to promote productivity in the United Kingdom. No applications for loans or assistance to United Kingdom firms from these funds will be accepted, therefore, after March 31.

It will be recalled that the funds were established in 1953 under an agreement between the governments of the United Kingdom and the U.S.A. This agreement provides for discussion between the two governments about the disposal of the moneys made available by the closing of the funds. In these discussions it has been agreed to transfer the funds to certain British territories in Africa where they will be used for purposes similar to those to which they have been applied in this country. On the industrial side, loans are made available to firms of small or medium size for the purpose of improving their productive efficiency. The average loan has been of £10,000 for a period of three-and-a-half to four years ; loans have been issued or are under negotiation for nearly £825,000 and about £420,000 has been repaid. Increases in production, with substantial savings in costs, have been reported by firms as a result of assistance from the industrial fund, although, the Board of Trade says, " the outlets for loans from the fund have not proved to be very many."

Wages and Costs

The annual general meeting of the British Employers' Confederation was held in London on Wednesday. The thirty-eighth annual report, which was submitted to the meeting, relates to the year 1957 and puts on record many matters upon which the Confederation's council deliberated during that period.

The introduction to the report directs attention to the fact that last year the retail prices index rose by 4½ per cent, although import prices fell by 4 per cent. The factor which continues to give the greatest cause for concern is wages, the report says, for during the year, with the level of industrial production having remained almost unchanged, weekly wage rates rose by 5½ per cent. It is added that almost the whole of this increase occurred during the first five months of last year. But, the report continues, weekly wage rates tell only a part of the story of increased labour costs. It has been the experience consistently over recent years for earnings to go up about one-third faster than weekly wage rates, a factor which, to some extent, is attributable to overtime and to genuine piecework earnings. According to the report, however, the view is widely held that much of this excess increase in earnings results from individual employers paying rates of wages and other benefits substantially above those negotiated between their employers' organisations and the trade unions concerned. In times of acute labour shortage, the report observes, this is perhaps not surprising and the practice would be self-correcting if its effect were to draw more labour into the market. That, however, is clearly not possible in present circumstances, the report goes on, for in no year since 1948 has the seasonal maximum unemployment in the United Kingdom exceeded 2½ per cent. All the indications are that there are few among those at present unemployed with the skills needed for the jobs on offer and that there are virtually no untapped reserves of workers in this country.

Clearly, the Confederation says, much responsibility rests on employers' organisations and trade unions and on those who are called upon to settle wages through arbitration tribunals or statutory wage-fixing bodies. But unless individual employers show restraint it cannot be expected that employers' organisations and trade unions can arrive at reasonable bargains on behalf of their constituents in their industries. The Government's measures and its declared determination to press these as hard as is necessary will limit the payment of extravagant wages by individual employers as they will find it increasingly difficult to pass on increased costs to their own customers. Meanwhile, it is urged, the increase of productive efficiency can do much towards preventing a further rise in labour costs and in prices and, in due course, towards bringing them down.

Building and Civil Engineering Work

According to provisional figures compiled by the Ministry of Works, the value of building and civil engineering work carried out in this country in the final quarter of 1957 was £537 million. This figure was the same as that returned for the third quarter, and as there was no change in building costs over the period the volume of work done was equal in both quarters. For the whole of 1957, the value of building and civil engineering work done is put at £2141 million, which was £64,000,000 above the 1956 total. The cost of new building work last year was, on average, about 3 per cent higher than in 1956, so that the volume of work done was about the same in both years. The Ministry's statement shows that in January of this year the total number of operatives employed by building and civil engineering contractors was 1,009,000, which was 52,000 fewer than a year earlier.

Employee Interviewing

The Department of Industrial Administration of the Birmingham College of Technology has stated that it is arranging a summer school in employee interviewing at the college at Gosta Green from June 16 to 27 inclusive. It will be directed by Mr. J. M. Fraser, Reader in Human Relations at the College.

This summer school has been held annually for the past five years, the methods employed being based, the Birmingham College of Technology says, on the " five-fold grading of human attributes and the biographical interview." The former provides a framework on which the demands of a job and the potentialities of the individual can be set out in comparable terms. The biographical interview enables the trends in an individual's behaviour to be discovered and interpreted so as to give an indication of what can be expected of him in the future. Past students are being kept in touch with the Department of Industrial Administration and with each other so that views and experiences can be exchanged. Some field studies have also been carried out on the application of the methods taught in the school to actual selection problems in industry. Thus, the College of Technology suggests, it may fairly be claimed that the beginnings of a body of common practice are being built.

At the summer school, practical work in the form of demonstrations, case studies and practice interviewing forms an essential part of the course. A visit to a local works is also included for the purpose of practice in preparing job specifications. This year's school will be open to managers and their assistants from all departments in addition to those who are directly concerned with the personnel function. Full details may be obtained from the Department of Industrial Administration, College of Technology, Birmingham, 4.

The T.U.C. and the Cohen Report

At a meeting of the general council of the Trades Union Congress, which was held on Wednesday of last week, the Cohen council's first report on prices, productivity and incomes was criticised on the grounds that it was a partisan and unimaginative document. A statement approved by the general council said that the Cohen report did little more than endorse the measures taken by the Government last September, support policies which have forced up the cost of living and urge wage restraint while, at the same time, encouraging higher dividends. Such one-sided and unimaginative conclusions, the statement added, would certainly not be regarded by workers as being objective and constructive. The report demonstrated, the T.U.C. said, that the Cohen council could not contribute towards a generally acceptable solution of the social and economic problems of Government and industry.

National Research Development Corporation

The National Research Development Corporation, which was established in 1948, has issued its eighth annual report covering the year ended June 30, 1957. The Corporation, it will be recalled, was set up by the Board of Trade, under the Development of Inventions Act, 1948, " to secure, where the public interest so requires, the development or exploitation of inventions resulting from public research, and of any other invention which is not in the Corporation's opinion being sufficiently developed or exploited." The Corporation can promote or assist research and development work designed to bring an invention to maturity for commercial exploitation ; it can finance the design and construction of experimental models or prototypes, and it can finance pilot-scale production.

The report emphasises the variety of projects sponsored by the Corporation ; they include, for example, digital computers, potato harvesters, a regenerative mechanical transmission system, a resin thermal insulating material, and an ion exchange membrane project. The report says that the Corporation is encouraged by its royalty income which continues to show a rising trend, and is derived from the sale of goods made under licence from the Corporation. The current annual total value of these sales, it is stated, has now to be reckoned in millions of pounds.

Continuous Casting Plant for Steel

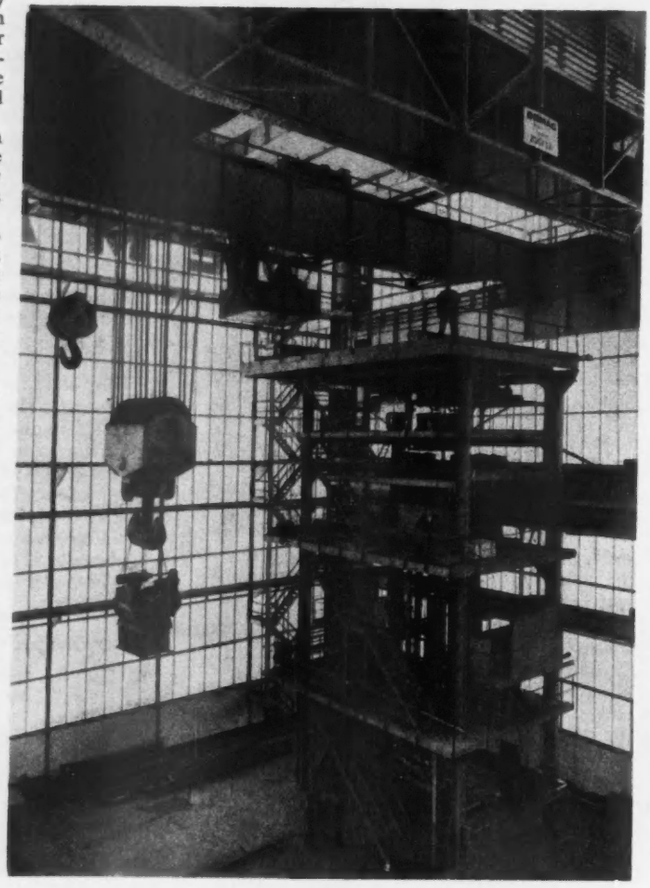
THE method of continuous casting of rolling mill blooms was introduced by S. Junghans in the early 1930s, who applied it to non-ferrous metals. Since 1948, it has been further developed by the Austrian firm Gebrüder Böhler and Co. A.G., Kapfenberg (Styria), and the German Mannesmann-Hüttenwerke A.G., Duisburg-Huckingen.

A continuous steel casting plant was put into service at the No. 1 Electro Steel Works at Kapfenberg in 1952. This plant, which was intended for full-scale experiments and production, processes all grades of steel manufactured by Böhler, including low and high-alloy steels, such as 13 per cent Cr–2 per cent C die steel, 18 per cent Cr–8 per cent Ni stainless steel, 12 to 14 per cent Mn–1 per cent C steel, and many others. In production are round sections (for drop forging) and rectangular sections (for the production of bars and sheet).

Mannesmann has been mainly interested in the production of low-alloy (Mo, Mo–Cr, C) steels for pipes.

It has been the experience of both companies that effervescent steels can be cast in sections from 180mm by 180mm upwards, although at only about 60 per cent the rate of killed steels. For rimming steels, the bubble-free zone extends about 20mm to 25mm into the interior of the cast strand. The quality is good in the case of sections and normal merchant in the case of sheet, but it is not of deep-drawing quality because of excessive contents of nitrogen and arsenic. The Böhler Company only uses Al-killed steels, and the high quality of the blooms may be judged from the fact that they form the basis for the firm's standard production.

The normal rolling process starts from ingots which have to be heated to the correct temperature in pit furnaces and require heavy cogging mills to reduce them to blooms or slabs suitable for the subsequent rolling stands.



Framework of continuous casting plant during works assembly. A set of feed rolls, with their hydraulic clamping device, may be seen being lifted by the crane

With continuous casting, on the other hand, the ingot casting and cogging stages are cut out and the slabs and blooms are produced directly by keeping a water-cooled, vertical, open mould filled with metal which, as it solidifies on the outside, is withdrawn at the bottom. Strictly speaking, although the cast strands are, the process itself is not, continuous, inasmuch as casting is done by means of a ladle and has to be interrupted when the ladle is empty. The casting, as it emerges, is cut into suitable lengths which are then transferred to a pusher furnace, from where they are fed into the mill. For various reasons, but mainly because of the discontinuity of the casting procedure, it has not been found practicable to feed a continuous rolling mill directly from the casting machine.

Besides the saving in capital equipment, it has been claimed for the continuous casting process that a higher output rate is being achieved. For slabs of 200mm by 240mm, output per mould is stated to be of the order of 11 to 12 tons per hour. Because it takes longer to remove the heat from a thicker casting, the downward speed decreases with thickness, while the weight of the casting increases. There is therefore an optimum thickness for maximum output which lies at about 150mm. The length of the section matters less. Moulds measuring 1000mm by 110mm are under construction, and larger sizes, say, 1500mm by 200mm, are considered feasible.

At neither the Böhler nor the Mannesmann steel works is any open-hearth steel processed by continuous casting, only electro steels are used. Because of the special demands on the quality, particular care is taken at Böhler's to exclude all moisture by preheating the ladles. It is stated that continuous casting resembles the casting of ingots inasmuch as the same faults can occur and be avoided by the same procedures. No difference has been found with regard to structure, although it would seem that the smaller sections acquire a finer crystal structure and show less segregation.

In order to exploit the Junghans patents, Böhler and Mannesmann have combined with Demag Aktiengesellschaft, Duisburg (agent, Rymag, Ltd., London, E.C.3), the latter company having acquired the world-wide rights for the manufacture of continuous steel casting plant. The first plant to be manufactured under this arrangement is now being completed at Duisburg. It is being made for Terni Società per l'Industria e l'Elettricità, Terni, Italy, and will have eight stands, two of 110mm by 110mm section and six of 140mm by 140mm. Either four or eight strands can be cast simultaneously, depending on whether an electric arc furnace and 35-ton ladle is used or a nominally 60-ton open-hearth furnace. The plant is designed to produce up to 200,000 tons annually. Casting speed is up to 2·5m per minute.

The following description refers to one of the two identical halves of the casting plant, which is illustrated herewith in a partially assembled state at the maker's works. It stands there 15·7m above the floor, but some 4·2m of this height will eventually be below floor level. As may be seen the equipment is arranged on a steel structure on five levels.

On the first level, the top platform, are the two casting troughs, one for eight and the other for four strands, which are to be used as alternatives as has been mentioned. The particular trough which is being used is kept filled from the ladle, maintaining a load of 200mm of metal. The steel is distributed to the four nozzles and the flow is controlled by plugs placed over these nozzles and movable in a vertical direction by means of hand levers. Initially, there will be one operator supervising each nozzle, but it is thought that later one operator will be able to look after two nozzles.

The distributor troughs, which are, of course, lined with refractory, can be shifted and tipped hydraulically from a control cabin (not illustrated). Through the ceramic nozzles, which have to be exchanged after each ladle, the metal flows in the form of a jet into water-jacketed copper moulds of the required section. In these moulds, which are about 1m high, the outer skin of the metal freezes to a depth of about 10mm, while the inside stays in a pasty condition. The distributor refractory is stated to last about the same length of time as a ladle, i.e. fifteen to forty melts. Pouring of one 60-ton ladle, it is stated, would take about one hour.

Each mould is bolted to the top plate of a cylindrical enclosure, the lower part of which contains four sets of vertical rollers between which the cast strand is guided downwards while it is further chilled by four rows of six high-pressure water jets playing upon its surface. Like all parts of the mechanism and structure exposed to the heat from the steel, the enclosure is double-walled and water jacketed. By means of an arm motor driven through an infinitely variable hydraulic gear, the enclosure, together with the mould and its assembly of rollers and water jets, is constantly rocked up and down at the rate of 30 to 100 times per minute. The stroke of this movement is up to ±12·5mm and can be varied by adjusting an eccentric. The machinery for this motion is mounted on the first platform down.

On the next platform are situated the feeder rolls and their associated drives. These comprise an 8kW, 960 r.p.m., 50 c/s, three-phase motor, which drives a 1000 r.p.m./0–970 r.p.m. infinitely variable hydraulic gear. The latter can transmit full torque of 10·2 mkg. to 16·5 mkg from 40 r.p.m. upwards. It is followed by a 750/24 r.p.m. reduction gear, which, in turn, drives the rolls.

These rolls are rimmed at each end and grooved axially so as to obtain a better grip. They are connected by four straight spur gears and the two arms on which they sit can be opened out and closed by a hydraulic cylinder. Special arrangements have been made by means of an accumulator to maintain the clamping pressure, even should the power fail at the oil pumps.

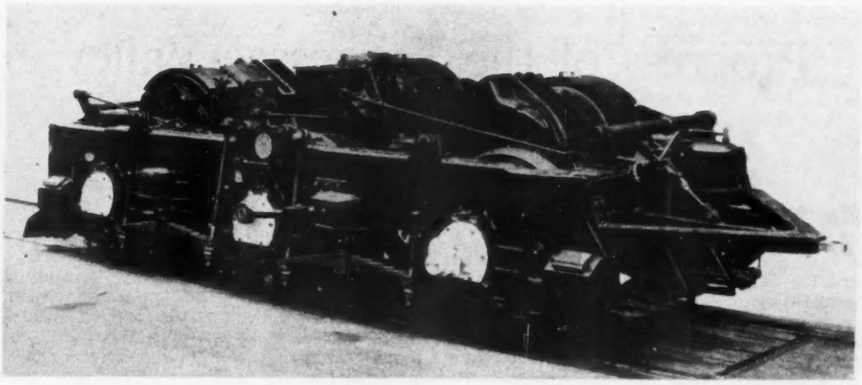
On the level below is the flame cutting machine. This is mounted on a carriage running on a vertical column. On the same carriage is fitted a hydraulically operated tongs which grips the bar as it is cut off. The carriage must therefore be able to move at two different speeds : first, during cutting at the same speed as the bar ; secondly, it must be able to lower the severed section at an increased speed. This is achieved by moving the carriage by means of a chain which passes over sprockets at the top and bottom and is counterweighted. By means of an electromagnetic clutch the top sprocket can be coupled to the roll drive, with which it will then move in synchronism. After cutting, the coupling is disconnected and a second similar coupling connects the bottom sprocket to a geared motor which provides the increased lowering speed.

The cutting-off is done under manual remote control through a d.c. motor on the carriage. The operator is seated in a control cabin at this

level and is in communication with the man at the top or other parts of the plant by portable radio telephone.

The cut-off bars are lowered into quiver-like receptacles which can be tilted through 90 deg. into a horizontal position and discharged on to a roller conveyor.

For starting the plant when the moulds are empty it is necessary to insert a plug of the correct section from below. This can be done by bringing in from the side two carriages from which are hung two 100mm by 100mm bars, one of which is tipped by an end piece which tapers out to the correct section. Bolted end to end and lifted by a traversing hoist up to where the feed rolls can grip them, the two bars can be pushed up further into the mould to act as starting plugs. When it is decided to shut down the plant and remove the tail end of the casting, an eye is embedded in the metal while it is still pasty, so that the bar, after being wound down to the level of the feed rolls, can be lowered to the ground by the hoist.



This design of bogie with three driven axles is steered by a link mechanism so as to avoid the need for a kingpin which would be in the way of the middle motor

Series 1010 Electric Locomotive

The Series 1010 locomotive of the Austrian Federal Railways (Oe. B. B.) is arranged for single phase a.c. of 16⅔ c/s, 15,000V, and laid out for a maximum hourly rating of 5400 h.p., supplied from six driving motors grouped in two three-axle bogies.

Built by Simmering-Graz-Pauker A.G., Vienna XI, the locomotive has been produced in two versions, one with bogies which are equipped with kingpins, the other a kingpin-less design. This is, therefore, a case where it will be possible to make a direct comparison between the two ways of dealing with the problem of steering the powerful C_0-C_0 bogies which are being so widely adopted in heavy electrical locomotives.

In the design which incorporates a kingpin, the difficulty is, of course, to find a place for it where it does not interfere with the middle driving motor. It was found possible to place the kingpin at the centre of an underslung bracket which has the shape of a figure X ; the horizontal arms being bent upwards through 90 deg. to connect with the locomotive frame. Should a bogie have to be removed for repair, a substantial amount of dismantling is required before it can be got out. Not so with the other kingpin-less design, which is shown diagrammatically in a B_0-B_0 version. A system of links connects the front part and rear of the bogie in such a manner that when the leading axle is deflected sideways in a curve, the trailing one is deflected in the opposite direction.

Our illustration shows the actual form which the kingpin-less bogies take. Each is built up from box girders which consist of two channels welded together at the flanges. Similar girders are used for the cross beams. The frame is fabricated and includes the axlebox supports, bearings for the springs and equalisation of the suspension, brackets for certain brake levers and supports for the motors, as well as the cow-catcher and snow plough attachments. The main brake bearings are bolted on.

The main motors, of which there are three on each bogie, can be dropped out at the bottom. The six sets of driving wheels have axles and discs of forged steel, with ring-lubricated bronze plain bearings. The rims of the central wheels are 5mm thinner than the others.

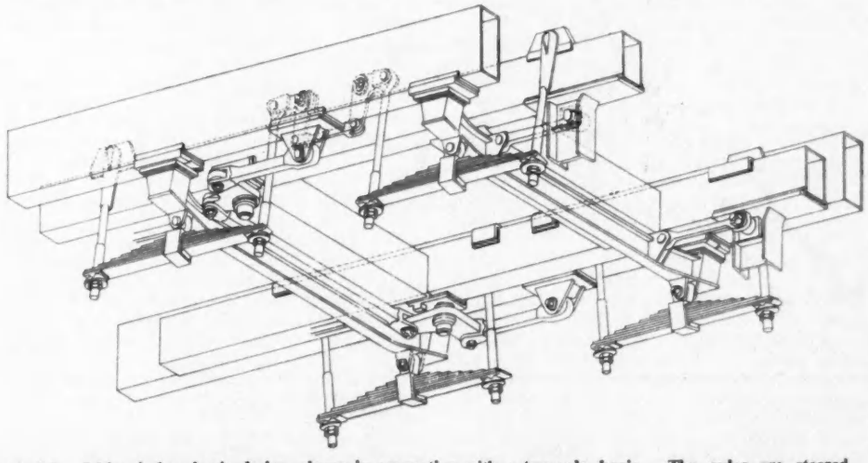
Transmission of the main weight as well as the pull between the superstructure and the bogies is by way of the cross beams.

Like the bogies, the locomotive chassis is also fabricated and comprises two main girders constructed from angles and flats, which are connected at both ends by box structures carrying the hooks and buffers, and at the bogies by four strong box-section cross girders. The hooks are designed for a pull of 32 tons ; the buffers are fitted with Verdinger annular springs. The superstructure is of profiles and folded sheets and is arc-welded throughout. Between the serrated, sub-divided aluminium floor and the chassis are pipe and cable ducts. In order to allow cranes to have access to the machinery, three roof sections are removable, the centre one over the transformer being raised.

The transformer, with its switchgear, is situated approximately in the centre of the machinery compartment and on the side of it opposite to the gangway are placed the oil reservoirs and compressed air container. Between the partitions behind each cab and the transformer are the welded equipment racks, which stand about 800mm above the floor and are covered with aluminium sheet. Some of the panels can be swung out to give access to the motor commutators. One of the frames carries the air compressor and its oil separator, the hand-operated air compressor, auxiliary switch and electrical resistances for this equipment, as well as a panel with the electric and electro-pneumatic valves associated with the compressed air and anti-skid brakes. The other frame houses a converter set, the switch for the heaters, the relay and fuse-board, auxiliary compressor and the two main air containers. All high-tension equipment is safeguarded by electrically protected grilles and doors. Two twin fans draw air through the lateral louvres behind which are the oil coolers, and push it through ducting to the main motors and associated equipment. Air admission is controlled by a butterfly valve in each suction duct.

Brakes.—The locomotive is fitted with a model "Ksn+z" quick-acting compressed air brake and two hand-brakes. Each bogie has its own brake gear, comprising two 14in brake cylinders, each for one and a half axles, i.e. they are arranged symmetrically about the midplane of the bogie. From either cabin both compressed air brakes can be operated but only the adjoining hand-brake. Up to a speed of 60km per hour the air brake brakes 73 per cent of the dynamic engine weight, over 60km per hour, 140 per cent. Besides the normal Oerlikon brake valve there is an additional valve, as well as an emergency valve. The hand-brake spindles are operated by means of chain and sprocket drives. Signalling is by means of compressed air whistles, one of which is fitted at each end of the roof. A "Hardy-König" sanding equipment is operated by electro-pneumatic valves and blows sand under the leading wheels of each bogie when travelling in either direction.

The locomotive is fitted with a central lubricating system. Principal data are given in the accompanying table.



Principle of kingpin-less bogie design, shown in connection with a two-axle bogie. The axles are steered by linkages, so that the trailing axle moves in the opposite direction to the leading one

Series 1010 *Single-Phase A.C. C_0-C_0 Locomotive with kingpin-less Bogies*

Current	Single phase a.c., 16⅔c/s
Voltage of conductor wire	15,000V
No. of driving motors	6
Continuous rating at motor shaft at v=99km per hour	6×560kw=3360kW
Hourly rating at motor shaft at v=90km per hour	6×665kW=4000kW
Continuous rating of transformer	3500kVA
Hourly rating at wheel rim	5400 h.p.
Continuous rating at wheel rim	4500 h.p.
Pull at wheel rim (hourly)	15,800 kg
Pull at wheel rim (continuous)	12,000 kg
Starting pull at wheel rim	26,000 kg
Gear ratio	1 : 3·185
Heater voltage (train)	1032V/820V
Maximum speed	130km per hour
Length over buffers	17,860mm
Length between bogie centres	8600mm
Axle spacing	2050+2050=4100mm
Wheel diameter	1300mm
Drive	B.B.C. with sprung gear-wheel
Weight of electrical portion	47 tonnes
Weight of mechanical portion	59 tonnes
Axle loading	17·6 tonnes
Service weight	106 tonnes
Axle bearing journal	170mm dia. by 260mm
Brake force (total), up to 60km per hour	92 tonnes
Brake force (total), over 60km per hour	175·8 tonnes
Brake force (hand-brake, per bogie)	42 tonnes

110MW Germanium Rectifier

It is announced by Société Alsthom, Paris, that it has obtained a contract for two germanium rectifiers, each rated at 55MW (100,000A, 550V), for supplying aluminium electrolysis cell lines. The equipment, which is to come into operation in 1960, has been ordered by Société Pechiney, one of the most important French aluminium manufacturers.

Progress of the Tennessee Valley Authority

BY OUR AMERICAN EDITOR

No. I

AMONG the several aspects of the T.V.A. programme for development, conservation and use of natural resources, flood regulation provided the most noteworthy events during the fiscal year 1957. As a result of a prolonged storm in late January and early February, the T.V.A. flood control facilities as well as the policies under which they are operated, confronted and successfully regulated the most severe flood conditions since the creation of the agency in 1933. The dams and reservoirs reduced the crest of the flood by about 22ft at Chattanooga, Tennessee, and averted an estimated 66,000,000 dollars in property damage. Substantial damage was also averted up and down mainstem of the Tennessee River and on its major tributaries and in the lower Ohio and Mississippi River Basins. Without the regulation provided by the reservoirs, the flood would have been the second largest ever to have been recorded at Chattanooga, reaching to within 4ft of the all-time record flood of 1867.

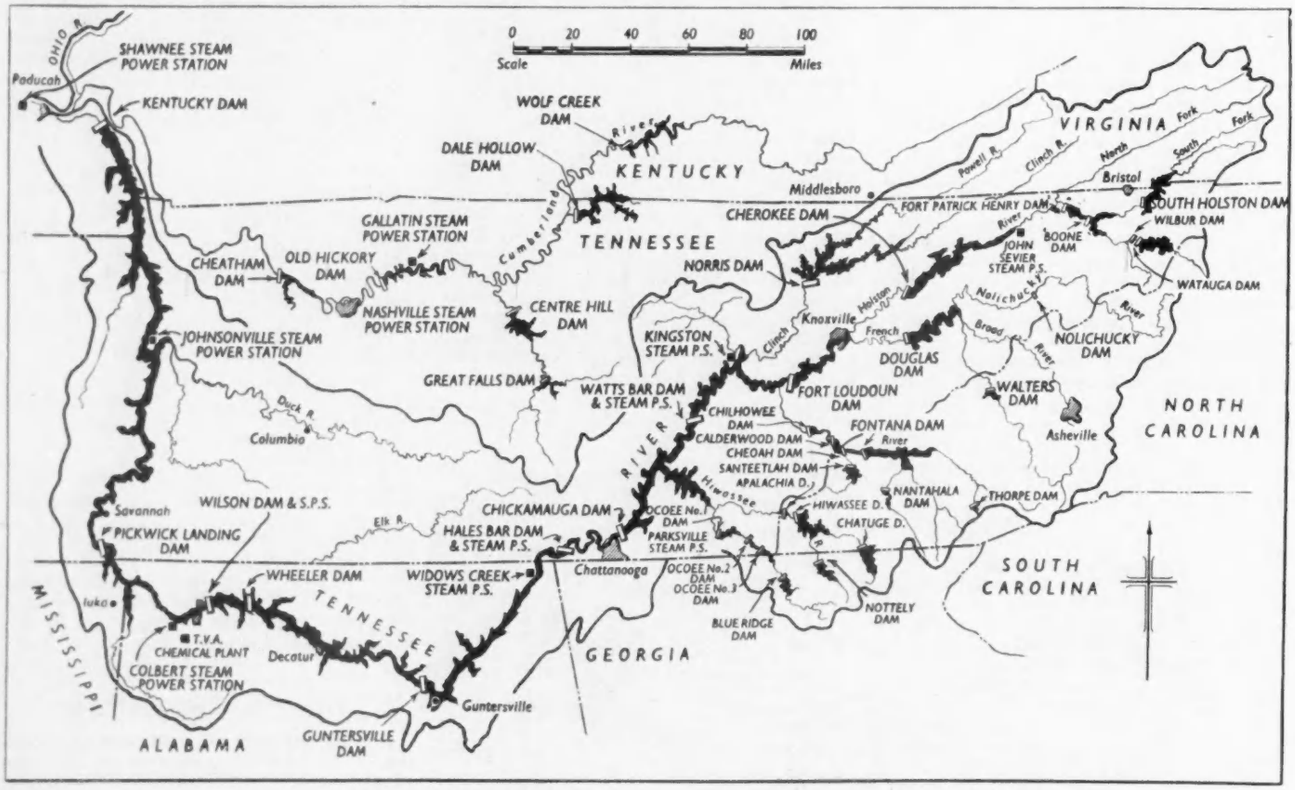
The continued economic growth of the region was reflected in other aspects of T.V.A. activities, notably in the use of the navigation channel and in power production and distribution. The Authority began the construction of a new large lock at the Wilson Dam to relieve the bottleneck to traffic which has developed at that point with the rapidly increasing use of the river. Good progress was made during the year in building the lock which, when completed, will be one of the highest single-lift structures in the world.

For the third consecutive year, more than half the power sold by the T.V.A. went to the U.S Atomic Energy Commission and other defence agencies. In the fiscal year 1957, U.S. Government defence purchases amounted to 31,700 million kWh of electricity out of total sales of 57,000 million kWh. The revenues from power operations amounted to 235·7 million dollars, an increase of 14,100,000 dollars over the previous year. The net income from the power operations for the fiscal year 1957 amounted to 58,100,000 dollars, representing a return of 4 per cent on the average net power investment of 1470 million dollars. This equalled the average annual return over the twenty-four year period of T.V.A. operations. The distributors of T.V.A. power—the ninety-eight municipalities, fifty-one electric co-operatives, and two small privately owned utilities which are the "retailers" of the power system—sold 15,700 million kWh of electricity, as compared with 14,500 million kWh in the fiscal year 1956. At the close of the year, they were serving 1,471,000 home, farm, business and industrial consumers, an increase of 36,000 during the year. The average residential consumption in the T.V.A. area amounted to 6023kWh per customer for the year ; this was about double the average residential use per customer in the United States.

Three large steam-electric generating units were placed in operation during the year, adding 585MW of installed capacity to the system. These additions, together with a 25MW generating unit placed in operation by the U.S. Army Corps of Engineers at the Old Hickory Dam on the Cumberland River, brought the total installed capacity of the integrated power system to 9,889,485kW. One of the steam units installed near the end of the fiscal year was the second 225MW generating unit at Gallatin steam plant power station. This addition concluded the extraordinary expansion of generating capacity which T.V.A. began in 1951 during the Korean War to meet the expanded power requirements of the Atomic Energy Commission for its plants at Oak Ridge, Tennessee and Paducah, Kentucky. The A.E.C. has long-term contracts with T.V.A. for 3125MW of power. At the close of the year, construction was continuing on seven additional steam-electric units at three steam power stations, all financed for the present from the revenues of power operations. They will add 1215MW of installed capacity to the system. Shortly after the close of the fiscal year, the Board authorised the construction of a 500MW generating unit at the Widows Creek steam power station in north-east Alabama. The new unit is to be financed, at least in the beginning, with power revenues. However, in view of the heavy revenue-financed programme now under way, consideration is to be given to financing the new unit with revenue bonds should legislation authorising the T.V.A. to issue such bonds be approved by the Congress. Recourse to bond financing also may be desirable with respect to a part of the cost of the seven steam-electric units now under construction.

Water Control

The successful regulation of the largest flood in T.V.A. experience—in fact the largest flood in ninety years and the second largest flood in the recorded history of the Tennessee River—was the outstanding aspect of water control operations in the fiscal year 1957. A storm occurring in the latter part of January and early February brought rainfall and run-off that, under natural conditions, without the control exercised by the T.V.A. system of dams and reservoirs, would have caused a flood catastrophe of national significance. At other points along the mainstem of the Tennessee and on its major tributaries severe damage would have been inflicted on homes, industry and Government installations. This was but one of a number of natural floods which the system has successfully regulated as a part of its multiple-purpose water control operations.



Dam	Miles above mouth	Height of gates above sea level, feet
Kentucky	22	375·0
Pickwick	207	418·0
Wilson	259	507·9
Wheeler	275	556·3
Guntersville	349	595·4
Hales Bar	431	635·0
Chickamauga	471	685·4
Watts Bar	530	745·0
Fort Loudoun	602	815·0

Fig. 1—Map of the Tennessee Valley region with sites of hydro-electric and steam power stations

Fig. 2—Spillway discharge at the Fort Loudoun dam to regulate the Tennessee River flow during the 1957 flood

Since Norris Dam was placed in operation in 1936, the system has reduced the crests of thirty floods which would have exceeded flood stage of 30ft as measured on the Chattanooga gauge. Four of the eight largest floods in the recorded history of the Tennessee River would have occurred in the past twelve years except for the regulation provided by the system. In 1946, 1947, and 1948, storms occurred which would have produced, under natural uncontrolled conditions, the sixth, seventh and eighth largest floods on record.

The integrated water control system of the Tennessee Valley (Fig. 1), consists of thirty major dams and reservoirs, nineteen of which are multi-purpose and eleven single-purpose. Nine multiple-purpose projects on the mainstem of the Tennessee create a navigation channel about 650 miles long from Paducah, Kentucky, to Knoxville, Tennessee, provide storage for flood control in the Tennessee and lower Ohio and Mississippi Basins, and have a large electric generating capacity. Ten of the multiple-purpose projects are situated on the five major tributaries of the Tennessee, where they provide a large storage capacity for flood regulation and, as the T.V.A. Act puts it, " maintain a water supply " for the navigation channel and for hydro-electric generation. Of the eleven single-purpose projects, all on the tributaries, six belong to T.V.A. and five to the Aluminum Company of America ; under an agreement with the company, T.V.A. directs the storage and release of water at the Alcoa dams as part of the operation of the integrated reservoir system. Shortly after the end of the fiscal year, Alcoa placed the Chilhowee Dam in operation on the Little Tennessee River, bringing the number of single-purpose projects to twelve and the number of major dams in the Valley to thirty-one.

On the average, nearly 52in of rain falls annually on the watershed. Some areas may receive as much as 70in or 80in. But the rainfall varies from year to year, from as little as 38in to as much as 63in. Again, on the average, a little over 22in or 43 per cent of the rainfall reaches the streams as run-off ; but this also varies widely, with as little as 11in and as much as 33in of run-off having been recorded during past years. Moreover, rainfall and run-off vary from season to season. As shown by the records of nearly a century, the greatest rainfall and run-off occur in the months January to April ; other months of the year have markedly less. Here again there is wide variation, in some winter seasons rainfall and run-off may be so concentrated as to cause one or more floods, while in other years there may be no dangerous high waters. Altogether, the system of dams and reservoirs in the Tennessee Valley provides about 14,500,000 acre-feet of useful controlled storage which is regulated to produce the greatest benefits. The task of the water control system, essentially, is to regulate the flow of water in the streams so as to minimise the wide variations that occur under natural conditions, reducing flood crests and conserving excess water, where possible, for navigation and hydro-electric generation.

The operation of this large and complex system to achieve such a variety of purposes requires quick and accurate information about weather and streamflow conditions. Consequently, a valleywide recording and reporting system has been created, with the water dispatching office in Knoxville, Tennessee, as its nerve centre. Observers throughout the area make periodic measurements of rainfall and streamflow. On remote mountain tops and in secluded valleys, automatic rainfall and streamflow gauges record the information and transmit it periodically by short-wave radio. The United States Weather Bureau, with which T.V.A. co-operates closely, provides weather data and forecasts daily, and during periods of flood danger makes more frequent forecasts as needed. At such times also the Corps of Engineers Office at Cincinnati reports conditions on the Ohio and Mississippi rivers which may affect T.V.A. operations, and the Authority in turn provides reports to Cincinnati. The United States Weather Bureau at Cairo, Illinois, supplies information on weather conditions in the lower Ohio and Mississippi Basins. Forecasting engineers in the water dispatching office assemble this mass of data and in a few hours pattern it into a valleywide picture—the amount of water in the system, the areas of greatest rainfall and run-off, the outlook for storms in the several sections of the basin, and other factors. With this information they can anticipate the inflow to each reservoir several days in advance. Decisions then must be made with respect to the impoundments at each dam—whether to store water or release it ; whether to increase power generation at one dam and cut back at another ; whether to use water only through the turbines or to discharge through sluices and spillways as well. Under ordinary weather conditions this process—assembling, analysing, deciding—takes place once a day. During flood periods, however, weather and river conditions may change rapidly and the procedure may be repeated two or three times in twenty-four hours.

The storm of January-February 1957 brought the Tennessee Valley from a period of drought into a period of great flood in only a few days. During the first part of the fiscal year, July to December, 1956, rainfall and streamflow were less than normal, and stored water was drawn upon to maintain power production. This lowering of the reservoirs was in conformity with the annual cycle of reservoir operations to provide storage space for the flood season. Under the operating guide curves developed from rainfall and run-off records of many decades, the lakes are drawn down sufficiently to provide storage of about 12,000,000 acre-feet by January 1 each year. However, the rains normally to be expected at the turn of the year did not materialise in 1957, and the draught upon stored waters continued in some reservoirs until mid-January. As a result, the tributary reservoirs had been drawn somewhat below the required levels for flood control when the storm began.

In mid-January, a front of cold air moving down from the North met a mass of warm, moisture-laden air coming up from the Gulf of Mexico, causing heavy rains. At first the front was situated a little north of the Tennessee Valley and reports of flood devastation came from numerous communities in the upper Cumberland River Basin and adjacent areas, as streams overflowed their banks. The storm then pressed slowly southward. Rain began to fall in the Tennessee Valley on January 21, and, except for one twenty-four-hour period, it rained every day for twenty-one days. In this three-week period about 12in of rain fell in the Tennessee Valley above Chattanooga. Nearly as much fell over the entire watershed. On Clingman's Dome, a 6600ft peak in the Great Smoky Mountains, a rain gauge recorded a total of 25in during the storm.

At first the rain was comparatively light, but it thoroughly soaked the ground, and run-off into the streams increased. Flows in the main river built up quickly and soon exceeded the capacity of the turbines at the main river dams. In addition to running the turbines at capacity, water was released through the spillways in order to get rid of the excess and maintain storage space in the main river reservoirs. Power generation at the tributary dams was cut back to keep water from the main river and to let the tributary reservoirs begin to fill. The storm increased in intensity. In the four

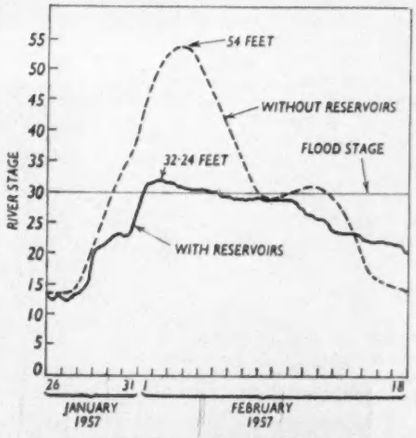
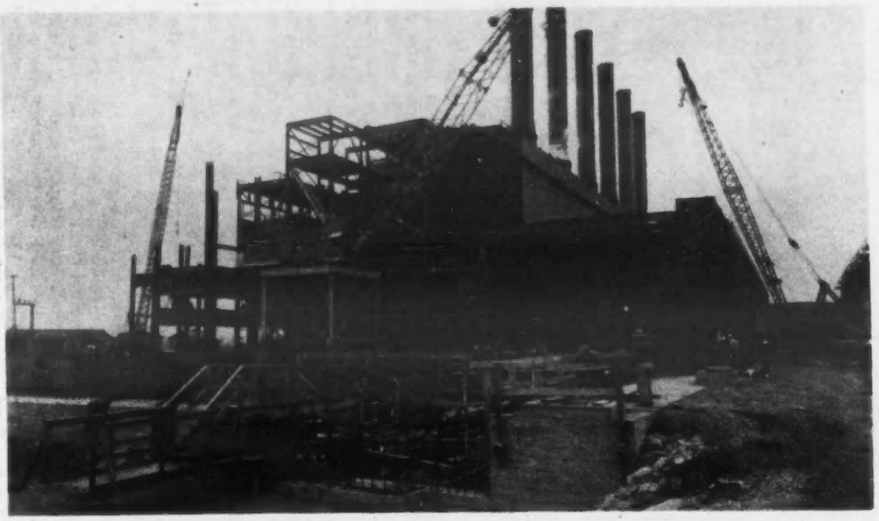
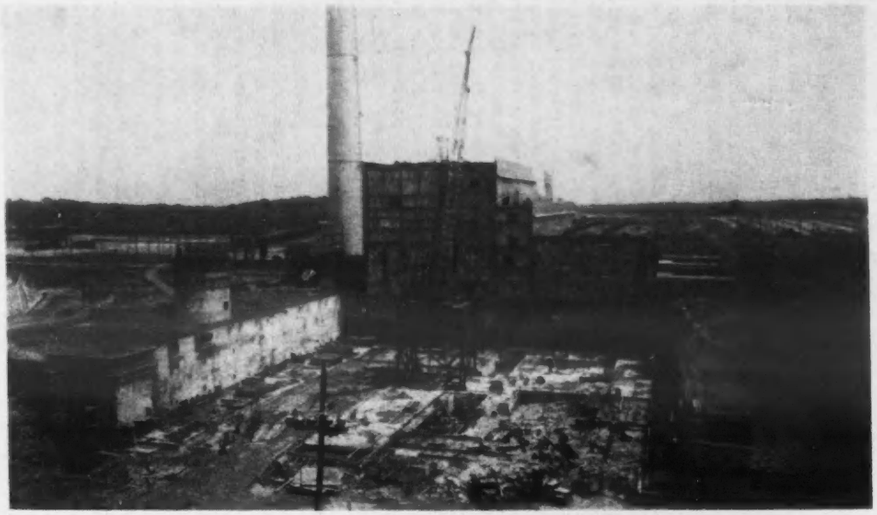


Fig. 3—Regulation of the 1957 flood crest at Chattanooga

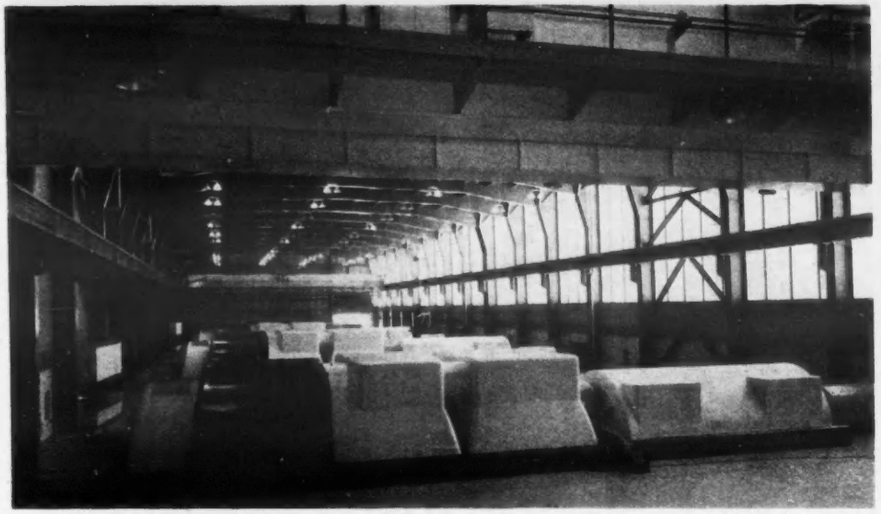
days from January 26, to January 29, 3in of rain came down. A situation favourable to the development of a major flood was created. The absorptive capacity of the soil had been reduced, run-off from soggy land increased, and still more rains were in the offing. At such a time, flood-control operations take precedence over all other water-control purposes. The system went into the first phase of the task of flood regulation. Because it is impossible to store all, or even the major proportion, of the waters of a great flood in the main river reservoirs, the first step is to pass as much water as possible downstream in advance of the natural flood crest. Accordingly, releases at the mainstream dams were stepped up. At the tributary dams, the turbines were shut off or were operated at low capacity to withhold water from the main river. However, as the flood developed the turbine use was increased to full capacity so as to maintain safe amounts of storage space in the reservoirs. At the mainstream dams the use of turbines was augmented by increased discharges through the spillways (Fig. 2). The flow throughout the system was accelerated. With the hydro-electric generating units all operating



Erection of structural steelwork for extension, comprising four 135MW units, at the Johnsonville steam power station



Foundation work for extension, comprising two 225MW units, at the Gallatin steam power station



Completed turbine room at the John Sevier steam power station, with four 180MW turbo-generators now in operation

Concrete placing operations at the Wilson dam lock, which will have a 110ft by 600ft chamber and provide a 100ft lift

at full capacity, the mode of operating the power system was changed. The hydro-electric units generated steadily to provide the base load while the steam power stations were used in such a way as to take care of most of the variations in generating requirements. This is the reverse of the usual practice for the combined steam and hydro system. Ordinarily the steam plants generate as continuously as possible to supply the base load while hydro-electric capacity, being more flexible in picking up and dropping loads as required, is used to meet fluctuations in power demand as they occur.

Now an even heavier rainfall took place. In the three days from January 30 to February 1, 4in of rain fell. As the flows increased, water regulation measures were keyed to the protection of the industrial city of Chattanooga, where the flood damage potential is greater than anywhere else in the Tennessee Valley. Late on January 31, with the heavy precipitation continuing and with additional rainfall indicated by Weather Bureau information, the water control engineers reached a decision to bring the regulated flow of the river at Chattanooga to a stage of 32ft, 2ft above flood stage. At about the same time, increased flows farther downstream at Muscle Shoals, Alabama, made it necessary to close lock No. 1 below the Wilson dam to navigation, constituting the beginning of a nine-day interruption of river traffic. The decision of January 31 required a delicate balancing of water control factors at the Fort Loudoun, Watts Bar, and Chickamauga dams, the three mainstream projects above Chattanooga. While holding flows for the protection of the city, it was necessary at the same time to reserve a reasonable amount of storage space in case flood conditions became worse. With the releases at these mainstream dams required by this operation, the river rose gradually to a stage of 32ft 3in on the Chattanooga gauge, remaining flows being impounded. With 206,000 cusecs of water coursing by the city, this was the crest of the flood as regulated by the T.V.A. system. Thus the second phase of flood control operations—withholding as much of the floodwaters as possible at the peak of the flood—was accomplished. As shown by the accompanying chart (Fig. 3), the regulated crest was nearly 22ft less than the natural crest would have been.

Of the storage space available in the reservoirs above Chattanooga, amounting to 8,000,000 acre-feet at the beginning of the storm, 4,000,000 acre-feet had been used. With releases restricted to turbine use, floodwaters had piled high behind the dams on the tributary streams. Inflows into the reservoirs were greater than at any time since the dams were built. During the flood period, the water level in the Norris reservoir rose 37ft, in Cherokee 42ft, in Douglas 56ft, in Fontana 69ft, and in Hiwassee 54ft. As rainfall slackened off and finally ended on February 10, the system entered the third phase of flood regulation operations—emptying the reservoirs to guide curve levels to be prepared for a possible succeeding flood. The water withheld from the main river during the major flood period and at the time of the flood peak

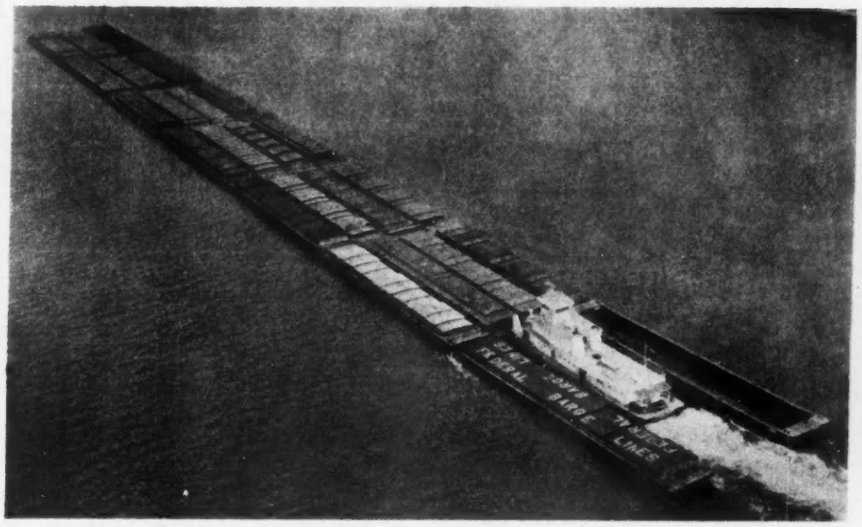


Fig. 5—Tow of twenty-four barges on the Pickwick reservoir, which is representative of the heavy freight movements on the Tennessee River waterway

now had to be passed on down the river. As a result, the flow in the Tennessee River remained high for some time. Both navigation and power operations were affected. On February 9, however, after being closed for nine days, lock No. 1 was re-opened to river traffic. By that time, twelve towboats and sixty-eight barges were tied up waiting to pass Wilson dam.

Throughout the flood period power generation was influenced by various factors. With an oversupply of water, the hydro-electric units at the main river power stations were loaded to their full capability from near the beginning of the storm to the end of February. Because of this steady operation, the system produced more hydro-electric power during this period than in any previous month. At the same time, the capability of the hydro system varied considerably. On the one hand, generating capability was increased by temporary storage in the tributary reservoirs which raised the operating heads at the dams. On the other hand, high tailwaters below the mainstream dams reduced the heads at those plants with resultant losses of capability although this was minimised considerably by the control of the floodwaters. On February 1, at the time of the crest of the flood, reductions in head accounted for a loss of 600MW of capacity. The maximum head loss, however, occurred on February 8, when it reached 670MW. This was almost one-fourth the amount of the peak load of 2929MW on the hydro-electric system that day. The head loss remained over 600MW from February 1 to 12 and averaged 460MW for the month of February.

The accompanying chart (Fig. 4) shows the guide curves for the operation during a year of the Chickamauga dam with its mainstream reservoir. The heavy broken lines show the way this reservoir was used in the 1957 flood and are typical of the operation of this dam.

The regulation of the January–February, 1957, flood by the T.V.A. system averted an estimated 66,000,000 dollars of damage at Chattanooga. Under natural conditions much of the city would have been inundated. Industrial areas would have been damaged, about 12,000 houses would have been flooded, and thousands of families would have been driven from their homes. Communications, transport and other services would have been disrupted. The reduction of nearly 22ft in the height of the floodwaters confined the out-of-bank floodwaters to low-lying, sparsely settled areas along local creeks. In addition, this and other T.V.A. flood-control operations during the fiscal year 1957 averted nearly 4,900,000 dollars of damage in the lower Ohio and Mississippi Basins.

The total estimated damage averted in these two areas—excluding substantial but not specifically estimated amounts for many other points in the Tennessee Valley—amounted to about 132 million dollars at the end of the 1957 fiscal year. This amount is equal to about 70 per cent of the total of 184 million dollars invested in the flood control provisions of the T.V.A. multiple-purpose system. At Chattanooga, T.V.A. is able to make unusually accurate estimates of damages averted as a result of a study of the city's flood problem made in 1938. Detailed block-by-block surveys were made by engineers with the help of trained appraisers familiar with property values and of the managers of industrial works. From the data obtained, T.V.A. compiled a flood damage curve, estimating the damage which would be caused by flood crests of various heights. In 1948, and again in 1953, these flood damage estimates were brought up to date to reflect increased property values and new developments.

However, potential flood damage along the Clinch River below Norris dam was studied recently. On the basis of this study, it is estimated that damage of about 250,000 dollars was averted in and below Clinton, Tennessee, where the crest was reduced by nearly 17ft. On the same stream substantial damage—in terms of interruption of operations probably amounting to millions of dollars—was averted at facilities of the Atomic Energy Commission at Oak Ridge. At Knoxville the crest on the Tennessee was lowered by nearly 17ft, thus averting damage to low-lying residential areas and some industries. At the Redstone Arsenal near Huntsville, Alabama, where some of the access roads were flooded, much of the area would have been isolated except for the regulation provided by the reservoir system.

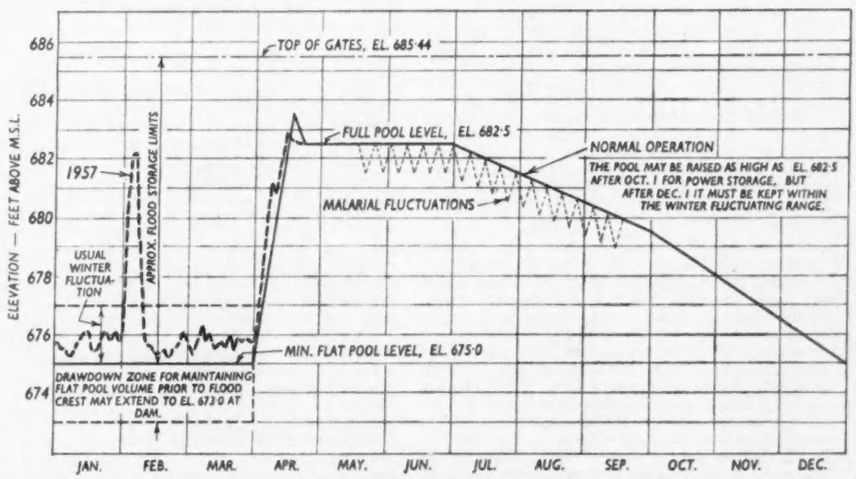


Fig. 4—Guide curve for the operation of the Chickamauga dam and reservoir, indicating the regulation of the 1957 flood

(To be continued)

Personal and Business

Appointments

MR. D. A. HUBBARD has been appointed a director of Aero Research, Ltd.

LT.-COL. S. J. M. AULD has joined the board of directors of Industries Group Sales, Ltd.

MR. L. L. G. VAUGHAN has been appointed sales office manager of Hardinge Machine Tools, Ltd.

MR. A. V. SOWMAN, M.I.E.E., has been appointed managing director of Crompton Parkinson (Chelmsford), Ltd.

MR. B. W. DAWKINS has been appointed chairman of Saxon Engineering Company, Ltd., and Bennis Mechanizations, Ltd.

DOWTY GROUP, Ltd., has announced that Mr. L. S. Flatman, A.M.I.Mech.E., has been appointed a director of Dowty Hydraulic Units, Ltd.

MR. F. H. LAWDER, chief labour superintendent of the United Steel Companies, Ltd., has been elected president of the Iron and Steel Trades Employers' Association in succession to Mr. W. F. Gilbertson.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has announced that Mr. A. E. Grimsdale, formerly manager, home sales, has been appointed director and commercial manager.

MR. NORMAN EDMENSON has been appointed to succeed Mr. J. Russell Knowles as managing director of Gulf Oil (Great Britain), Ltd. Mr. Knowles has retired. Mr. J. R. Smellie has been appointed vice-managing director.

MR. J. R. BUNCE has been appointed commercial manager at the Willesden Works of Lancashire Dynamo and Crypto, Ltd., in succession to Mr. W. H. Cable, who has retired after thirty-seven years' service with the company.

THE STEEL COMPANY OF WALES, Ltd., has announced the appointment of Mr. M. C. Harrison as manager of the new Bessemer steel plant, which is now under construction at Abbey Works. Mr. P. Truscott has been appointed assistant manager.

Business Announcements

GIRLING, Ltd., Birmingham, states that its telephone number is now Acocks Green 3371.

MR. H. H. J. CHENNELL, contracts manager of the Fairey Aviation Company, Ltd., since March, 1944, has retired.

FREDERICK W. EVANS, Ltd., Plastic Works, Long Acre, Birmingham, 7, has opened a new and enlarged toolroom.

TWIFLEX COUPLINGS, Ltd., states that Caselco, Ltd., 46, Park Square, Leeds, has been appointed sole selling agent for the County of Yorkshire.

BLACK AND DECKER, Ltd., has established a subsidiary company, Black and Decker (Nederland) N.V., at 109, Vondelweg, Rotterdam.

POWDER METALLURGY, Ltd., has changed its address to Berk House, P.O. Box 500, Portman Square, London, W.1 (telephone, Hunter 6688).

CINEMA-TELEVISION, Ltd., Worsley Bridge Road, Lower Sydenham, London, S.E.26, announces that it has changed its name to Rank Cintel, Ltd.

PARK ROYAL VEHICLES, Ltd., has announced that Sir Joseph Napier, Bt., and Mr. Herbert C. B. Berens have resigned from the board of directors.

LE GRAND, SUTCLIFF AND GELL, Ltd., states that it will open a Middle Eastern office at Attar Street, Karrada Sharquiyah, Baghdad, under the direction of Mr. G. Vann, early in March.

INTERNATIONAL COMBUSTION, Ltd., and International Combustion (Products), Ltd., have opened a new office at 22, St. Mary Street, Cardiff (telephone, Cardiff 26648). Mr. R. W. Allison has been placed in charge of this office.

DECCA RADAR, Ltd., and the Decca Navigator Company, Ltd., have announced that their head offices have moved to a new building, Decca House, Albert Embankment, London, S.E.11 (telephone Reliance 8111).

MICHIGAN (GREAT BRITAIN), Ltd., has announced that Clark Equipment International and its British associate, All Wheel Drive, Ltd., have completed arrangements for the manufacture of Michigan earth-moving and materials handling equipment in the United Kingdom.

THE BRISTOL AEROPLANE COMPANY, Ltd., states that a subsidiary company, the Bristol Aeroplane Company (S.A.) (Proprietary), Ltd., has been formed in Johannesburg. Mr. C. F. Uwins is chairman of the new subsidiary and Mr. Noel Holman has been appointed managing director, resident in Johannesburg.

STANDARD TELEPHONES AND CABLES (SOUTH AFRICA) (PROPRIETARY), Ltd., Johannesburg, has concluded arrangements with the South African Post Office for the supply of telecommunication transmission equipments to meet all the department's requirements. A formal agreement, effective for ten years, has been signed in Cape Town.

Contracts

THE NATIONAL GAS AND OIL ENGINE COMPANY, Ltd., has received an order from the Christchurch (N.Z.) Drainage Board for four "R4AP" four-cylinder dual-fuel engines for a new sewage purification plant. Each of the engines will develop 233 b.h.p. on oil and 209 b.h.p. on gas at 680 r.p.m.; a sewage pump is driven from the flywheel end of each engine, whilst an air blower is driven from the free end.

THE ENGLISH ELECTRIC COMPANY, Ltd., states that the U.S. Army Corps of Engineers has placed a further order for Table Rock power station, White River, Missouri, with English Electric Export and Trading Company, Ltd. The new contract, valued at about 220,000 dollars, is for a second generator transformer for the station, which is a duplicate of the one ordered from the company in November, 1955. It is a 90,750/121,000kVA, 13·2/161kV, three-phase, 60 cycles power transformer, with all accessories and spare parts.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., of Manchester, has secured a contract worth £2,500,000 from Elektrim, the official Polish organisation dealing with the import of electrical equipment. The two steam turbo-generators are believed to be the largest ever ordered in this country for installation in Europe. They will be delivered in 1961. The two reheat turbo-generators will have three-cylinder turbines running at 3000 r.p.m. The steam conditions are to be 1800 lb per square inch at 1000 deg. Fah. reheated to 1000 deg. Fah. Hydrogen-cooled generators at a pressure of 30 lb per square inch will operate at 120,000kW, 0·8 p.f., 13·8kV, three-phase, 50 cycles.

Miscellanea

"DIWABUS" AUTOMATIC TRANSMISSION.—In our issue of October 4, 1957, we referred to the "Diwabus" automatic transmission in use on passenger vehicles displayed at the International Motor Show, Frankfurt. This transmission, of which the new "200 S" version for powers up to 200 h.p. is now in quantity production, is a development of J. M. Voith G.m.b.H., Heidenheim (Brenz).

PNEUMATIC CIRCUITS.—A new publication of the Climax Rock Drill and Engineering Works, Ltd., Carn Brea, Redruth, Cornwall, is entitled "*Maxam*" *Pneumatic Equipment for Production*. It describes in some detail fifty typical pneumatic control circuits and provides a useful guide for engineers, designers and others not fully acquainted with the potentialities of air control systems.

COMPUTER FOR OIL COMPANY.—The Shell Petroleum Company, Ltd., intends to install in its London office a high-speed electronic computer system to perform calculations covering commercial aspects of all activities from exploration to marketing. The equipment, based on the Ferranti "Mercury" machine, with additional punched card, magnetic tape and high-speed printing units, will be able to store the equivalent of more than 60,000,000 decimal digits at a time.

TRANSISTOR FILMS.—Three 16mm sound films on transistors are available from the Publicity Division, Mullard, Ltd., Torrington Place, London, W.C.1. The first film, "The Transistor: Its Principles and Equivalent Circuit," is in colour and is intended for those who have a background knowledge of electronics and thermionic valve circuits. The second film, in monochrome, deals with the junction-transistor in radio receivers and is in two parts, dealing, respectively, with the design of an i.f. amplifier and with the complete receiver. The third film, also in monochrome, deals with the manufacture of junction-transistors.

DISC FILING MACHINE.—A rotary disc machine for filing, trimming and shaping metals and materials not readily cut by grinding wheels is being made under the trade name of "Discut" by Stanley Works (G.B.), Ltd., Rutland Road, Sheffield, 3. This machine has a non-clogging cutting disc 10in diameter, driven through gearing at about 400 r.p.m. by an electric motor. The disc of thin steel has the teeth punched out and is supported on a spoked backing plate. These supporting spokes are designed to draw air through the teeth perforations and keep the disc cool. An adjustable work table in front of the disc can be set to support workpieces at any required angle, and the machine can be supplied with a pedestal cabinet or for bench mounting.

INTERNAL GROOVING TOOL.—A tool now available from Geo. Salter and Co., Ltd., West Bromwich, provides a means for cutting grooves in bores, concentric to the bore diameter, and to very close tolerances, on standard drilling machines, capstans, centre lathes, automatics or milling machines. When used on a drilling machine, as the spindle is lowered into the job a bush, or bottom adapter, of the tool pilots into the bore to locate the cutter in its position to begin cutting the required groove. Continued downwards pressure of the machine spindle causes the cutter to move outwards in an eccentric movement, until the required depth of groove is attained. When this depth is reached further movement of the machine spindle is prevented by the action of a stop within the tool. As the pressure on the spindle is relieved the cutter returns to its neutral position, and the tool can be withdrawn from the bore. The standard tool is available in five sizes covering bore diameters from ¾in to 4in.

LIGHTWEIGHT HOIST.—A portable, hand-operated chain hoist of ½-ton capacity, now being made by Yale and Towne Manufacturing Company, Wednesfield, Wolverhampton, weighs only 33 lb. Its aluminium-bronze load sheave is carried in ball bearings, and a self-actuating screw and disc brake is designed to increase the pressure in proportion to the load. A downwards pull on the hand chain releases the brake and allows the load to be lowered. Heat-treated alloy steel gears and pinions are used in the hoist, and the support and the load hooks of drop forged steel swivel freely on ball bearings. With a full load a pull of 70 lb is required on the operating chain of the hoist.

LONG-MATERIAL CARRYING ATTACHMENT.—The British Hoist and Crane Company, Ltd., Compton, Berkshire, has introduced an attachment for its "Iron Fairy" hydraulic mobile cranes, which facilitates the transport of lengthy materials such as poles, piles, standards and steel sections. This attachment consists of a steel platform fitted to one side of the crane, opposite to the driver. Long loads picked up can be lifted and slewed round and lowered on to the platform and the jib returned to its original lowered position to enable a crane with its load to pass through a doorway 7ft. 9in wide and 9ft high. To facilitate the operation the front portion of the platform attachment is made in a telescopic form. Loads of 30 cwt and measuring 20ft or more can be carried, and anchor chains are included for securing the load while travelling.

INSTITUTION OF NAVAL ARCHITECTS.—The spring meeting of the Institution of Naval Architects will be held in the Weir Lecture Hall, 10, Upper Belgrave Street, London, S.W.1, March 25 to 27. On Tuesday morning, March 25, the Annual General Meeting will be held, followed by a paper, "Brittle Fracture in Welded Ships," by J. Hodgson and G. M. Boyd. Four papers will be presented on Wednesday, "The Design, Construction and Operation of a Class of Twin Screw Tugs," by E. C. B. Corlett, M.A., Ph.D., J. Venus and C. Gibson, and "Progressive Towing Trials for Full Scale Inland and Shallow Draught Vessels," by J. M. Sweet, B.Eng., in the morning, followed by "Losses of Small Ships," by C. V. Manley and "The Hydrofoil Boat: Its History and Future Prospects," by P. R. Crewe, M.A. The meeting will conclude on the morning of Thursday, March 27, with the reading of "Scale Effect Experiments on Victory Ships and Models," Part II, by J. D. Van Manen and A. J. W. Lap, and "The Effect of Surface Roughness on the Performance of a Model Propeller," by J. M. Ferguson.

MERCHANT SHIPS LAUNCHED IN 1957.—Lloyd's Register of Shipping has issued its *Annual Summary of Merchant Ships Launched During* 1957. In Great Britain and Northern Ireland, 50 steamships and 210 motorships of 1,413,701 tons gross were launched and accounted for 16·6 per cent of the world output, compared with 20·7 per cent for the previous year. Of the total, 45 ships of 535,333 tons, or 37·9 per cent, were oil tankers, and 47 ships, of 261,392 tons, or 18·5 per cent, were for registration abroad. Elsewhere in the world, 215 steamships and 1475 motorships, totalling 7,087,703 tons, were launched, and included 2,432,506 tons by Japan, and 1,231,152 tons by Germany. The oil tankers launched amounted to 269 ships of 3,315,368 tons, or 46·8 per cent of the total, of which Japan's share was 106 ships of 1,378,678 tons. The world output totalled 265 steamships and 1685 motorships of 8,501,404 tons gross, of which 28·6 per cent were built in Japan and 14·5 per cent in Germany. Included in the total were 314 oil tankers of 3,850,701 tons, or 45 per cent of world output, of which Japan built 36 per cent and Great Britain and Northern Ireland 14 per cent. Of all the ships launched, 645 of 4,092,955 tons, or 48·1 per cent, were being built under the survey of Lloyd's Register.

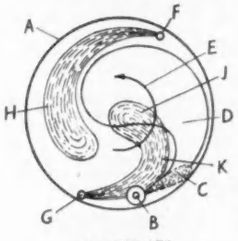
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

INTERNAL COMBUSTION ENGINES

790,071. July 14, 1955.—COMPRESSION-IGNITION ENGINES, Maschinenfabrik Augsburg-Nürnberg, Aktiengesellschaft, Nürnberg, Germany.

The invention relates to a method of injecting water into compression-ignition engines in particular, a high-speed diesel-type engine, described in principle in Specification No. 749,825. It is the purpose of the invention to avoid the premature disintegration of the fuel, which occurs during the combustion process and has an inconvenient effect on the quiet running of the engine. In the drawing, *A* denotes the combustion chamber orifice, *B* the fuel nozzle, whose jets *C* are directed tangentially against the wall of the combustion space in such a way that they form on it a fuel film *D*. Looking from above at and into the combustion space, the fuel film *D* is formed spirally along the wall in the direction of the motion of the air, indicated by the arrow *E*, towards

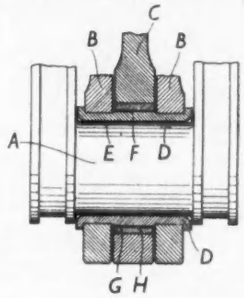


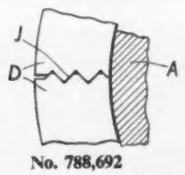
No. 790,071

the deepest point of the combustion space. The fuel nozzle *B* and two further nozzles *F* and *G* are adjacent to the circumference of the mouth of the combustion chamber. The nozzles *F* and *G*, for the injection of water, are each arranged along the circumference of the combustion space orifice at some distance from the fuel nozzle *B*. The water film *H* produced by the nozzle *F* is placed adjacent to but separate from the fuel film *D* and envelops the film. With some types of fuel it may be convenient to let the two films mix to some extent, as shown at *J*, where fuel *D* and water film *K* produced by nozzle *G* merge with one another. It is also possible to keep all the films separate from but adjacent to one another. The invention is naturally applicable to all types of internal combustion engines and shapes of combustion spaces where the injection and mixture-forming process on which the invention is based is applicable.—*February* 5, 1958.

788,692. January 24, 1956.—CONNECTING ROD BEARING ARRANGEMENTS, Maybach-Motorenbau G.m.b.H., Friedrichshafen, Germany.

The invention relates to connecting rod bearing arrangements of the type in which more than one connecting rod is journalled on a single crankpin. In the drawing *A* is a crankpin of a crankshaft having disc-shaped webs, *B* is the forked connecting rod, and *C* is the blade connecting rod. Split bearing brasses *D* of a high-strength bronze providing an emergency





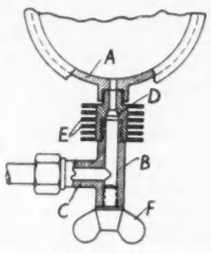
No. 788,692

running period are fitted in the forked connecting rod *B*. The bearing brasses *D* have internally, adjacent the crankpin *A*, thin galvanised bearing surfaces *E* of lead about 2/100mm thick. Layers *F* of lead of equal thickness are provided on the bearing brasses *D* externally, adjacent the blade connecting rod *C*. The blade connecting rod has split bearing brasses *G* of steel with an internal layer of chromium *H*. Instead of the chromium layer, a hardened case may be produced by nitriding or like treatment. The lower view shows on a larger scale a view of the serrations *J* on the bearing brasses *D* at the joint between the two halves.—*January* 8, 1958.

BURNERS AND SPRAYERS

789,921. January 31, 1956.—OIL BURNERS, Burger Eisenwerke G.m.b.H., Burg/Dillkreis, Germany.

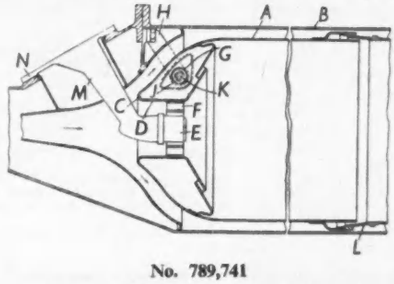
A disadvantage with oil burners, especially vaporising burners, resides in the fact that when oils rich in residue are burned, incrustation occurs on the inner walls of the oil feed pipe due to the deposition of oil, coke or the like, with the result that the passage becomes obstructed. The invention provides means whereby the incrustation is largely prevented from forming. Referring to the drawing, *A* is the vaporiser cup and *B* is the oil feed pipe having a portion *C* at right angles. An intermediate piece *D* formed from a material such as "Monel" metal having a lower heat conductivity than the material from which the vaporiser cup *A* and the oil feed pipe *B* are formed, is interposed between the oil feed pipe and the vaporiser cup. The intermediate piece *D* is provided with cooling fins *E* of copper, having higher heat conducting properties than the material from which the intermediate piece *D* is made. The oil feed pipe *B* is closed at its lower end by a wing bolt *F* which can be readily removed to afford access for cleaning purposes.—*January* 29, 1958.



No. 789,921

789,741. December 9, 1954.—LIQUID FUEL COMBUSTION APPARATUS, Joseph Lucas (Industries), Ltd., Great King Street, Birmingham, 19. (*Inventor: James Albert Whitehead.*)

The invention relates to liquid fuel combustion apparatus in which a combustion chamber is contained in an air jacket to which air for combustion of the fuel is supplied by a blower, and required for jet-propulsion engines, gas turbines, air or water heaters, industrial furnaces or other purposes. Its object is to enable the combustion chamber to be mounted in the air jacket in a convenient manner. Referring to the drawing, a single combustion chamber *A* of sheet metal is contained within a surrounding sheet metal air jacket *B*. The end of the combustion chamber to which the fuel is supplied is shaped to form a hollow nose *C* of conical or other desired contour, and has at its centre a short axial duct *D* in which is contained the fuel nozzle *E* and a surrounding air swirler *F*. The adjacent part of the air jacket is shaped to a corresponding form, so that air supplied to the entrance of the air jacket can pass in part to the duct, and in part to the annular space surrounding the combustion chamber. Through a



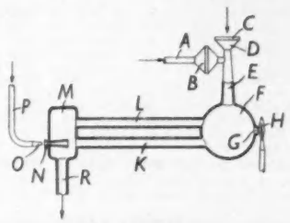
No. 789,741

part of the nose situated at one side of the duct is inserted transversely a tube *G* which is secured at its ends to the nose. To an adjacent part of the air jacket are secured a pair of inwardly extending brackets *H* to accommodate between their inner ends the ends of the tube. Preferably, the tube is reinforced by a bush *J*. Attachment of the combustion chamber to the brackets is effected by a hinge pin *K* inserted through holes in the inner ends of the brackets and the tube or bush. In the example the nose piece *C* is shaped to provide a part of reduced width having a pair of flat sides through which the tube *G* is inserted and which lie between the brackets. The other and open end of the combustion chamber is removably supported by slidable engagement with the adjacent end of the discharge pipe *L* or flame tube, carried by the air jacket. Alternatively, it may be supported by an annular abutment, or a ring of studs, in the air jacket. The fuel is supplied to the nozzle *E* through a pipe *M* removably carried by a fitting *N* mounted on the air jacket.—*January* 29, 1958.

COMBUSTION CHAMBERS

789,701. November 1, 1955.—OSCILLATING COLUMN COMBUSTION APPARATUS, Junkers and Co., G.m.b.H., Junkersstrasse, Wernau am Neckar, Germany.

The object of the invention is the provision of means which will enable operation of an oscillating column combustion apparatus to be initiated automatically, these means requiring no separate source of power, and possessing no moving parts. As will be seen in the drawing, a main gas pipe *A* having a gas admission valve *B*, and an air intake connection *C* having a fitted air-intake valve *D*, lead to a neck-shaped inlet connection *E* of a combustion chamber *F*. The wall of the combustion chamber has an ignition aperture *G*, in front of which burns a pilot flame *H*. Two resonant tubes *K* and *L* having a similar cross-section, are connected in parallel. These tubes communicate with a common exhaust chamber *M* and are also connected to the combustion chamber *F*. An injector *N* projects into the exhaust chamber.



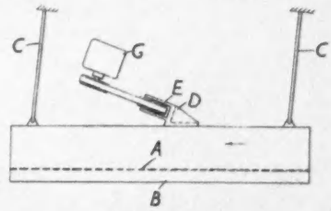
No. 789,701

The jet nozzle *O* of this injector is connected outside the exhaust chamber to a further auxiliary gas pipe *P* and the injector extends into the exhaust chamber *M* nearly as far as the mouth of the resonant tube *K*. An exhaust pipe *R* leads off from the chamber. In such a combustion apparatus the use of two resonant tubes, instead of a single tube with twice the cross-sectional area, has the advantage that the tubes each have a smaller radius than when a single tube is used with the correspondingly greater cross-section. The arrangement operates as follows: when gas is supplied to the jet nozzle of the injector, a gas and air mixture is introduced into the combustion chamber *F* through the resonant tube *K*. The exhaust gases present in the resonant tubes and in the combustion chamber *F* are expelled through the second resonant tube *L* by the in-flowing gas-and-air mixture. The combustible mixture is then ignited by the pilot flame *H*. Thus, periodic combustion will be started in the combustion apparatus, gas being aspirated from the main gas pipe *A* and air induced through the air intake connection C.—*January* 29, 1958.

SCREENING OF MINERALS

790,137. June 21, 1955.—SCREENING APPARATUS, W. H. Barker and Son Engineers, Ltd., Etna Works, Fenton, Stoke-on-Trent. (*Inventor: Wilfred Barker.*)

The invention relates particularly to a screening apparatus comprising a flat fine-mesh screen used for sorting and dehydrating wet mineral or other materials by a vibratory action, but can be used for other analogous screening purposes. Its object is to provide an improved arrangement wherein both the desired flow and circular motions of the particles can be



No. 790,137

obtained. One manner of carrying the invention into effect is shown in the accompanying drawing. A flat screen *A* in a frame *B* is suspended by links *C* or otherwise supported so that it can receive a gyratory motion. Also, it is sufficiently inclined to effect the required movement of the material along the screen. To the upper side of the frame of the screen is attached a bracket *D* carrying a rotary unbalanced wheel *E*, this being driven by any convenient means, such as an electric motor *G* and a belt. The wheel *E* is arranged in a plane which has an opposite inclination to the plane of the screen. By such an arrangement the particles are agitated by a circular motion relatively to the screen and, at the same time, are given the desired progressive movement along the screen.—*February* 5, 1958.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, March 7.—LIVERPOOL AND DISTRICT BRANCH: Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, 2, "Through Central Europe," J. G. P. Anderson, 7.30 p.m.

Tues., March 11.—PORTSMOUTH BRANCH: Wiltshire Lamb Hotel, Portsmouth, "Power Factor Correction," P. A. Haywood, 7.30 p.m. ★ YORK BRANCH: Royal Station Hotel, York, "Fluorescent Tube Manufacture," J. S. Grey, 7.30 p.m.

Wed., March 12.—BIRMINGHAM BRANCH: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Switchgear for Automation," W. E. Hill, 7.30 p.m. ★ BRADFORD BRANCH: Midland Hotel, Bradford, "Colour Television," G. N. Patchett, 7.30 p.m. ★ LUTON BRANCH: Luton and Dunstable Chamber of Commerce, George Street West, Luton, "Electronic Measuring Instruments," E. R. Ashford, 8 p.m.

Fri., March 14.—STOKE AND CREWE BRANCH: Royal Hotel, Crewe, "Storage Batteries," D. L. Jayne, 7.30 p.m.

Sat., March 15.—OXFORD, READING AND DISTRICTS BRANCH: Collier Lecture Room, Regents' Park College, Pusey Street, Oxford, "The Industrial Uses of Radio-Active Isotopes," 7 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., March 12.—NORTH EASTERN SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "Industrial Television," S. G. Gobbi, 6 p.m. ★ WEST MIDLANDS SECTION: Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton, "Analogue Computers," K. C. Garner, 7.15 p.m.

Thurs., March 13.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Automatic Reading of Typed or Printed Characters," C. E. G. Bailey, 7 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 10.—SHEFFIELD CENTRE: Grand Hotel, Sheffield, "Lighting Research at the Building Research Station," R. G. Hopkinson, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

Mon., March 10.—DUNDEE BRANCH: Mathers Hotel, Dundee, Annual General Meeting, 7.30 p.m. ★ MERSEYSIDE AND NORTH WALES BRANCH: The Blossoms, Chester, Annual General Meeting, Film, "Mechanical Seals," 7.15 p.m.

Tues., March 11.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, Annual General Meeting, 7.15 p.m.

Wed., March 12.—GLASGOW BRANCH: More's Hotel, Glasgow, Annual General Meeting, 7.15 p.m.

Thurs., March 13.—NORTH EAST BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, Annual General Meeting, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., March 12.—SOUTHAMPTON SECTION: Technical College, St. Mary's Street, Southampton, "Fifty Years of Art Founding," A. L. Parrott, 7.30 p.m.

INSTITUTE OF FUEL

Tues., March 11.—MIDLAND SECTION: Old M.E.B. Lecture Hall, Stoke-on-Trent, "Recent Developments in Gas for Ceramic Firing," L. Walker and K. Davis, 7 p.m.

Wed., March 12.—NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, "Application of the B.P. Corrosion Control Process in Industry," G. Whittingham and L. K. Rendall, 2.30 p.m.

Thurs. March 13.—SOUTH WALES SECTION: B.P. Refinery, Llandarcy, "Oil Fuel Applications with Special Reference to Wales," T. Chippindale, 6 p.m.

INSTITUTE OF MARINE ENGINEERS

To-day, March 7.—SCOTTISH SECTION: Robert Gordon's College, Aberdeen, "Nuclear Steam Propulsion for Merchant Ships," W. R. Wootton, 7.45 p.m.

Tues., March 11.—LONDON SECTION: Memorial Building, 76, Mark Lane, London, E.C.3, two papers on "Controllable Pitch Propellers," J. R. Getz and B. Resfnes, and L. Pehrson, 5.30 p.m.

Thurs., March 13.—NORTH EAST COAST SECTION: Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne, "Corrosion Control in Tankers," A. Logan, 6.15 p.m. ★ SOUTH WALES SECTION: South Wales Institute of Engineers, Park Place, Cardiff, Film, "Research and Development in the Lubricating Oil Field with Special Reference to Marine Engineering," A. A. Kelly, 7 p.m. ★ WEST MIDLANDS SECTION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Materials for Superheater Tubes and Supports," D. W. Crancher, 7 p.m.

INSTITUTE OF METALS

Mon., March 10.—SCOTTISH LOCAL SECTION: Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "A Metallurgist in the Chemical Industry," L. Powell, Annual General Meeting, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., March 10.—EAST REGIONAL CENTRE: Council Chamber, Houldsworth Hall, 90, Deansgate, Manchester, "Petrol Injection," J. N. Morris, 7.30 p.m.

Wed., March 12.—SOUTHERN CENTRE: Polygon Hotel, Southampton, "Some Notes on Fuel Injection Equipment for Road Transport," J. Skinner, 7.30 p.m.

Thurs., March 13.—NORTH REGIONAL CENTRE: Commercial Hotel, Accrington, "The Commer T.S.3. Two-Stroke Diesel Engine," E. W. Coy, 7.30 p.m.

Fri., March 14.—WESTERN CENTRE: Duke of Cornwall Hotel, Millbay Road, Plymouth, "The Construction and Operation of the Distributor Pump," 7 p.m. ★ SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, Open Forum, 7 p.m.

INSTITUTE OF WELDING

Wed., March 12.—FIRST ANNUAL LECTURE: Conference Hall, Institute of Welding, 54, Princes Gate, Exhibition Road, London, S.W.7, "The Influence of Welding on Structural Design," Professor Sir Alfred Pugsley, 6 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., March 12.—NORTH WESTERN BRANCH AND YORKSHIRE GRADUATES AND STUDENTS' CENTRE: Chemistry Department Lecture Theatre, The University, Leeds, "Sulphuric Acid from Anhydrite at Whitehaven," A. C. Halfpenny, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 11.—Great George Street, Westminster, London S.W.1, Films, "The Conservation of Natural Resources," H. R. Lillie, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., March 10.—NORTH EASTERN CENTRE: Neville Hall, Newcastle upon Tyne, "Results of Full-Scale Stability Tests on the British 132kV Grid System," F. Busemann and W. Casson, 6.15 p.m. ★ INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "The Industrial Designer—An Ally or Enemy of the Engineer," opened by M. Black, 5.30 p.m. ★ LONDON GRADUATES AND STUDENTS' SECTION: Institution of Civil Engineers, Great George Street, London, S.W.1, Joint Meeting, "The International Geophysical Year," Vice-Admiral Sir Archibald Day, 6.30 p.m. ★ SOUTH MIDLAND CENTRE: Winter Gardens, Malvern, "Measurement of Magnetic Fields by Proton Resonance Method," G. C. Lowe; "Tracking the Earth Satellites with the Aid of Radio Interferometry," D. B. Yale, 7.30 p.m. ★ SOUTH MIDLAND SUPPLY AND UTILIZATION GROUP: College of Technology, Birmingham, "Operational Experience at a Nuclear Power Station," K. L. Stretch, 6 p.m. ★ WESTERN CENTRE: Bristol University Engineering Laboratories, University Walk, Bristol, "The Development of Variable Speed High-Power Drives for Large Wind Tunnels"; "A Variable-Frequency Power Installation for Large Wind-Tunnel Drives," P. McKearney, L. S. Drake and E.G. Mallalieu, 6 p.m. ★ MERSEY AND N. WALES CENTRE: M.A.N.W.E.B. District Office, Buttermarket Street, Warrington, "Modern M.V. Switch and Control Gear," E. H. Norgrove, 6.30 p.m.

Tues., March 11.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "A Ferrometer for the Determination of the A.C. Magnetization Curve and the Losses of Small Ferromagnetic Sheet Samples," H. Blomberg and P. J. Karttunen, to be read by F. Brailsford; "Direct-Reading Iron-Loss Testing Equipment for Single Sheets, Single Strips and Test Squares," J. McFarlane, P. Milne and J. K. Darby; "The Control of Flux Waveforms in Iron Testing by the Application of Feedback Amplifier Techniques," J. McFarlane and M. J. Harris, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Assembly Hall, 3 (Tels.) Training Bn., R.E.M.E., Arborfield, Berks, "The Fidelity Limits of Monaural Sound Reproduction," J. B. Helder, 7 p.m. ★ NORTHERN IRELAND CENTRE: Civil Engineering Dept., David Keir Building, Queen's University, Belfast, "Cathodic Protection," L. B. Hobgen, K. A. Spencer and P. W. Heselgrave, 6.30 p.m. ★ RUGBY SUB-CENTRE: Technical College, Rugby, "D.C. Winder Drives Using Mercury-Arc Rectifier/Inverters," L. Abram, J. P. McBreen and J. Sherlock, 6.30 p.m. ★ BEDFORD DISTRICT BRANCH: Swan Hotel, Bedford, "The Transatlantic Telephone Cable," R. J. Halsey, 7.15 p.m.

Wed., March 12.—SUPPLY AND MEASUREMENT SECTIONS: Savoy Place, London, W.C.2, "A Method of Analysis of Transformer Impulse Voltage Distribution Using a Digital Computer," Beryl M. Dent, E. R. Hartill and J. G. Miles, 5.30 p.m. ★ LONDON GRADUATE AND STUDENT SECTION: Visit to the Decca Record Company, Ltd., 2.30 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: N.W.E.B. Demonstration Theatre, Friargate, Preston, "Electrical Equipment for Rectifier Locomotives," H. B. Calverley, E. A. K. Jarvis and E. Williams, 7.15 p.m. ★ OXFORD DISTRICT BRANCH: Southern Electricity Board, 37, George Street, Oxford, "High-Voltage D.C. Transmission, with Special Reference to Cross-Channel Cable," F. J. Lane, 7 p.m.

Thurs., March 13.—UTILIZATION SECTION: Savoy Place, London, W.C.2, "The Use of Steel-Tank Mercury-Arc Inverters for Generating Medium Frequencies for Induction Heating," D. L. Smart and J. L. Weaver, 5.30 p.m. ★ NORTH SCOTLAND SUB-CENTRE: Electrical Engineering Department, Queen's College, Dundee, "Electrical Floor Warming," J. W. Moule and W. M. Stevenson, 7 p.m. ★ SOUTH MIDLAND CENTRE: College of Technology, Gosta Green, Birmingham, "The Place of Computers in Electrical Engineering Design," W. E. Scott, 6.15 p.m. ★ WEST WALES (SWANSEA) SUB-CENTRE: Conference Rooms South Wales Electricity Board Showrooms, The Kingsway, Swansea, "The Use of Nuclear Devices," D. Taylor, 6 p.m.

Fri., March 14.—NORTH EASTERN GRADUATE AND STUDENT SECTION: Grey Hall, King's College, Newcastle upon Tyne, "Electricity in Western Australia," R. G. Harvey, 6.30 p.m. ★ NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "Electrical Floor Warming," J. W. Moule and W. M. Stevenson, 7.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., March 10.—Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Design and Construction of the St. Michel Reflector," D. E. Walker, 7.15 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., March 11.—39, Elmbank Crescent, Glasgow, C.2, "Further Applications of Three-Dimensional Extrapolation Methods," A. J. W. Lap, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, March 7.—LONDON BRANCH: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Off-Street Parking," R. Chinn, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 7.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, Ordinary Meeting in Conjunction with the Steam Group, "Modern Reheat Practice in Steam Power Stations," F. H. S. Brown and J. W. H. Dore, 6 p.m. ★ SCOTTISH BRANCH: North British Hotel, Edinburgh, "A Review of Applications of Radioisotopes to Engineering," J. L. Putman, 6.30 p.m.

Tues., March 11.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, "The Inspection of Vehicles for Roadworthiness," G. Grime and R. D. Lister, 6 p.m. ★ BIRMINGHAM A.D. CENTRE: George Hotel, Wolverhampton, "Air Suspension for Road Vehicles," J. H. Sainsbury, 6.30 p.m.

Wed., March 12.—LUTON A.D. CENTRE: Town Hall, Luton, "Recent Developments in Petrol Injection," E. W. Downing, 7.30 p.m.

Thurs., March 13.—HYDRAULICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Pipe Joints (with special reference to Slight Movements Due to Thermal Expansion), Glands and Seals," 6 p.m. ★ YORKSHIRE BRANCH, The University, Leeds, "Electronic Computers," A. S. Douglas, 6.30 p.m.

Fri., March 14.—1, Birdcage Walk, Westminster, London, S.W.1, Technical Film Show, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., March 10.—LEEDS SECTION: Hotel Metropole, King Street, Leeds, 1, Annual General Meeting, "The Design and Manufacture of Glass Forming Machinery," C. A. Nichols, 7 p.m. ★ SHEFFIELD SECTION: Grand Hotel, Sheffield, Annual General Meeting, Film, "Copy Turning," 6.15 p.m.

Tues., March 11.—DONCASTER SECTION: Danum Hotel, Doncaster, Annual General Meeting and Film Evening, 7.15 p.m. ★ BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting and Graduate Chairman's Address, by T. B. Wilcox, 6.30 p.m.

Wed., March 12.—DUNDEE SECTION: Technical College, Dundee, Annual General Meeting, 7.30 p.m. ★ S. ESSEX SECTION: Mid-Essex Technical College and School of Art, Chelmsford, Annual General Meeting and Film, 7.30 p.m. ★ WESTERN GRADUATE SECTION: Royal Hotel, College Green, Bristol, 1, Annual General Meeting and Film Show, 7.30 p.m.

Thurs., March 13.—ROCHESTER SECTION: Sun Hotel, Chatham, "Human Relations in Industry," J. M. F. Maslin, 7.30 p.m.

Fri., March 14.—IPSWICH AND COLCHESTER SECTION: Davey Paxman and Co., Ltd., Colchester, "Work Study," R. S. Warne, Annual General Meeting, 7 p.m. ★ SWANSEA SECTION: Central Library, Alexandra Road, Swansea, "Training for Industry," R. B. Southall, 7.30 p.m.

INSTITUTION OF PUBLIC HEALTH ENGINEERS

Thurs., March 13.—Caxton Hall, Westminster, London, S.W.1, "Weather and Atmospheric Pollution," Renald Frith, 6 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., March 10.—MANCHESTER SECTION: Technical College, Newton Heath, "Some Thoughts on Compounding Materials," J. H. Carrington, 6 p.m. ★ S. WALES AND MONMOUTHSHIRE SECTION: Angel Hotel, Cardiff, "Industrial Design in the Rubber Industry," T. E. H. Gray, 7.30 p.m.

Tues., March 11.—LONDON SECTION: National College of Rubber Technology, Holloway, London, N.7, "Modern Methods of Tyre Building and Vulcanising," E. Hornby, 5.30 p.m. Research Lectures and Demonstrations, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, March 7.—MIDLAND COUNTIES BRANCH GRADUATES AND STUDENTS' SECTION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Practical Aspects of Soil Mechanics and Site Investigation," K. H. Head, 6.30 p.m.

Mon., March 10.—LANCASHIRE AND CHESHIRE BRANCH: College of Science and Technology, Manchester, "Shear Effects in Reinforced Concrete Beams," R. B. L. Smith, 6.30 p.m.

Wed., March 12.—YORKSHIRE BRANCH: Central Electricity Authority Offices, Leeds, "Stabilised Soil Pavements at Southend-on-Sea Airport," T. B. Hill, 6.30 p.m.

INSTITUTION OF WORKS MANAGERS

Mon., March 10.—MANCHESTER BRANCH: Grand Hotel, Manchester, "Present-Day Industrial Relations," Sir Frederic Leggett, 6.45 p.m.

Wed., March 12.—LONDON BRANCH: Caxton Hall, Caxton Street, London, S.W.1, "The Application of Industrial Engineering Techniques," (No. 3), Informal Talk by Mr. S. C. Brown, followed by Discussion, "Cost Control," 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 7.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Films, 7 p.m.

Mon., March 10.—N.W. SECTION: Engineers' Club, Albert Square, Manchester, "High Pressure Hot Water Heating," N. Fincher, 7.30 p.m. ★ SHEFFIELD AND DISTRICT SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, "The Distribution System of a Public Electricity Supply Undertaking," A. Haddock, 7.30 p.m.

Fri., March 14.—ORDINARY MEETING: Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Available Energy," R. D. Gifford, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Wed., March 12.—Liverpool Engineering Society, The Temple, Dale Street, Liverpool, "Non-Ferrous Tubes in the Stress of Modern Conditions," C. Breckon, 7 p.m.

NEWCOMEN SOCIETY

Wed., March 12.—Science Museum, London, S.W.7, "Landmarks in the History of Weighing and Measuring," C. St. C. B Davison, 5.30 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, March 7.—Lecture Theatre, Mining Institute, Newcastle upon Tyne, "Experimental Investigations on Natural Circulation in Watertube Boilers," A. M. Laird and A. S. T. Thomson, 6.15 p.m.

PLASTICS INSTITUTE

Thurs., March 13.—The University, Leeds, "Plastics in Conveyor Belting, with special reference to Mines," C. G. Addingley, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Mon., March 10.—NORTH WESTERN BRANCH: College of Technology, Sackville Street, Manchester, Joint Meeting with Institution of Structural Engineers, "Shear Effects in Reinforced Concrete Beams," R. B. L. Smith, 6.30 p.m.

Wed., March 12.—LONDON BRANCH: 11, Upper Belgrave Street, London, S.W.1, "Prestressed Concrete—A Review," F. Walley, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., March 13.—CHRISTCHURCH BRANCH MAIN LECTURE: Technical College, Bournemouth, "The Problems Arising from The Use of Deflected Engine Thrust for Reducing Aircraft Approach Speeds," P. F. Ashwood and D. Lean, 7.30 p.m.

ROYAL INSTITUTION

Fri., March 14.—21, Albemarle Street, London, W.1, "Artificial Satellites," H. S. W. Massey, 9 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Thurs., March 13.—12, Great George Street, London S.W.1, "Gravity Surveys," J. E. Jackson, 5.45 p.m.

ROYAL SOCIETY OF ARTS

Wed., March 12.—John Adam Street, Adelphi, London, W.C.2, "World Hunger as a Biochemical Problem," N. W. Pirie, 2.30 p.m.

ROYAL STATISTICAL SOCIETY

To-day, March 7.—LONDON GROUP: Institute of Physics, 47, Belgrave Square, London, S.W.1, "A Review of Some Sampling Inspection Schemes," I. D. Hill, 6 p.m.

Mon., March 10.—SOUTH WALES GROUP: University College, Cathays Park, Cardiff, "The Use of a Computer in a Monte Carlo Synthesis," R. Neate, 6.30 p.m.

Tues., March 11.—MERSEYSIDE GROUP: Royal Institute, Colquitt Street, Liverpool, "Management Accounting," W. J. Jennett, 7 p.m.

Wed., March 12.—EDINBURGH GROUP: Hall of the Institute of Chartered Accountants, 27, Queen Street, Edinburgh, "Market Research," J. F. Hayes, 7.45 p.m. ★ NORTH EASTERN GROUP: Old Staff Room, Armstrong Buildings, King's College, Newcastle upon Tyne, "Some Applications of Statistics to Research on Animal Nutrition," A. W. Boyne, 7 p.m. ★ STUDY SECTION: Room 8, London School of Economics, Houghton Street, London, W.C.2, "Planning and Organising Budget Surveys," W. F. F. Kemsley, 6 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Tues. and Wed., March 11 and 12.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Symposium on the Protection of Motor Vehicles, 9.30 a.m. and 2.30 p.m.

SOCIETY FOR WATER TREATMENT AND EXAMINATION

Fri., March 14.—Library, Royal Society of Health, 90, Buckingham Palace Road, London, S.W.1, Annual General Meeting, 9.30 a.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., March 14.—39, Elmbank Crescent, Glasgow, C.2, "Use and Application of the 'Quantovac,'" S. Muir, 6.45 p.m.

Advanced Engineering Courses

Basic Principles of Nuclear Engineering. DEPARTMENT OF EXTRA-MURAL STUDIES, THE UNIVERSITY, Liverpool. Easter Vacation Course, April 13 to 19. Course of sixteen lectures, together with demonstrations, discussions, and a tour of the work at the University Nuclear Physics Laboratory. Fee £15 15s. residential. £10 non-residential.

Operational Research. UNIVERSITY OF BIRMINGHAM, INSTITUTE FOR ENGINEERING PRODUCTION, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham. Residential Executive Course, from 9.30 a.m., Monday, March 17, until 4 p.m., Friday, March 28. Fee £50, non-residential £40.

FRANCIS CAIRD INC.

420 Lexington Ave.,
New York. 17, N.Y.

This establishment, located at Grand Central Terminal, in Central New York (with branches in Mid-West and associate companies Toronto, Montreal, Vancouver) was set up largely to further the sale of British and European equipment for Oil, Chemical, Marine, Process, and Power Generating Industries.

Manufacturers, who feel that a close contact in all or any of these areas would be to their advantage, are invited to submit details to :

FRANCIS CAIRD LIMITED

Africa House, Kingsway, London, W.C.2.
Milburn House, Dean Street, Newcastle.
National House, St. Ann Street, Manchester.

SPRAY NOZZLE

NON-CLOGGING
INVOLUTE TYPE

¼" to 3" Dia. Inlet.
Capacities 2½ to 12,000 G.P.H.

For Water Cooling, Gas Washing, Dust Laying and other purposes.

LEDWARD & BECKETT LTD

PARLIAMENT MANSIONS • ABBEY ORCHARD ST.
PHONE: ABBEY 5429 **LONDON, S.W.I.**

CYLINDERS
VESSELS • CONES

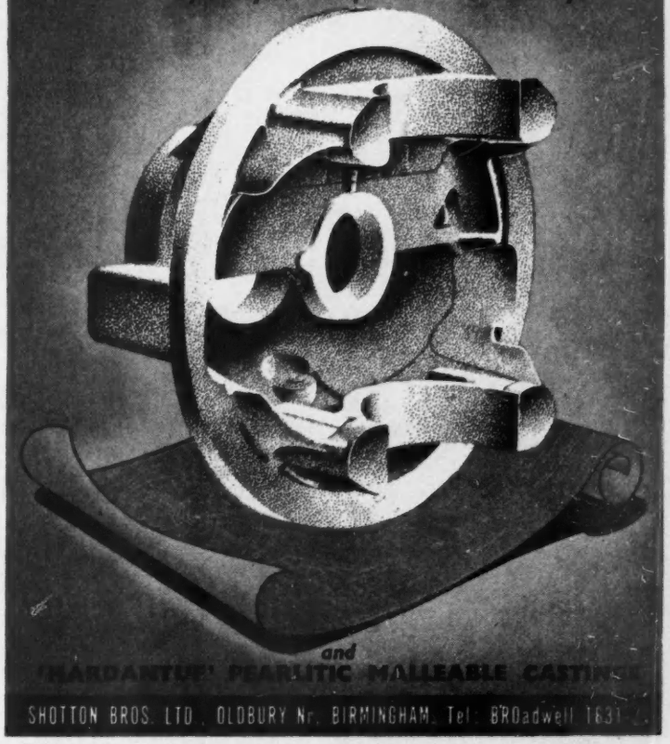
ALL FABRICATIONS

Modern Conveyors LIMITED

ADDERBURY EAST **NR. BANBURY, OXON**
Telephone : ADDERBURY 238

SHOTTON

For
BETTER BLACKHEART MALLEABLE IRON CASTINGS
Backed by 60 years experience & technique



and
'HARDANTUF' PEARLITIC MALLEABLE CASTINGS

SHOTTON BROS. LTD., OLDBURY Nr. BIRMINGHAM. Tel: BROadwell 1631

We are now booking capacity for our New Modern Foundry at Halesowen.

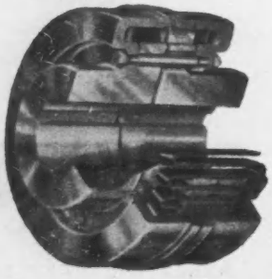
HAMMERED OR HYDRAULIC PRESSED

FORGINGS

IN STEEL
BLACK OR MACHINED
TO 24 TONS

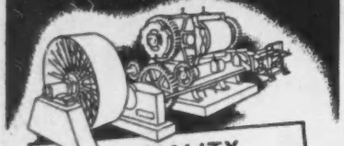
INCE FORGE CO. WIGAN
PARKS FORGE LTD
PROPRIETORS

BIBBY COUPLINGS



THE WELLMAN BIBBY Co., Ltd.,
Parnell House, 25, Wilton Road, London, S.W.
Telephone: ABBEY 1194

BENNETT & SAYER
LIMITED
Established 1877
ENGINEERS IRONFOUNDERS
& GENERAL MILLWRIGHTS



SPECIALITY
Plastic brick machinery to suit all clays, any capacity

NUNS FOUNDRY, NUNS STREET
DERBY
Telegrams: BENNETT & SAYER, DERBY
Telephone: OFFICE and WORKS—45546

BRAND NEW
BALL & ROLLER
BEARINGS
OVER 4,000,000 IN STOCK
IN MORE THAN 4,000 TYPES

BRITAIN'S LARGEST STOCKS
Consisting of HOFFMANN, R. & M., S.K.F., F.B.C., POLLARD, TIMKEN, TORRINGTON, HYATT, M.R.C., N.D., FAFNIR, FAG., RIV., STEYR, G.M., S.B.O., A.K.F., ONA, GIUSTINA, ETC. ETC.

SUPPLIERS TO AIR MINISTRY, MINISTRY OF SUPPLY, ADMIRALTY, NATIONAL COAL BOARD, PUBLIC UTILITY UNDERTAKINGS, OVERSEAS GOVERNMENTS, ETC. ETC.

Exporters to all parts of the World
Write for New Stock List.

CLAUDE RYE BEARINGS
[illegible] FULHAM ROAD, LONDON, S.W.6
RENOWN 0176 (EXT. 24) TELEX 2-1453

The choice is often difficult

- DIE CASTINGS in Brass, Bronze or Aluminium, cut costs by the reduction of machining and finishing operations and by the virtual elimination of machining allowances.
- BRASS PRESSINGS, on the other hand, can be produced so rapidly that, in many cases, the nett unit cost is lower.

The problem is to choose the most suitable process for your needs.

Why not call in the Non-Ferrous people first? They can advise you well for they make *both!* Together with their associate company, Brass Pressings (London) Ltd., they conduct joint administrative, technical and engineering operations under one roof . . . their recommendations to you are therefore sound and unbiased.

If requested, our technical representatives will be pleased to advise you without obligation.

BRASS PRESSINGS (LONDON) LTD.

THE NON-FERROUS DIE CASTING CO., LTD.

NONFERDICA WORKS, NORTH CIRCULAR ROAD, LONDON, N.W.2 Telephone: GLAdstone 6377
I-45

UX11

A question of corrosion?

PLUS-GAS

THE ANTI-CORROSION SPECIALISTS

have the answer

Consult our Technical Advisory Service which covers the United Kingdom

PLUS GAS CO. LTD

1/11 Hay Hill, London, W.1.

Tel: HYDe Park 9566/9 Grams: Abfluids, Piccy, London.

BASIC DATA
For Future Reference

RUBBER COMPONENTS

GASKETS and OIL SEALS
AUTO-MOTIVE MOUNTINGS
RUBBER-TO-METAL BONDING
EBONITE PRODUCTS
GENERAL MECHANICALS

IN
NATURAL and SYNTHETICS,
NEOPRENE, SILICONES ETC.
RUBBERISED CORK, ETC.

SPONGE RUBBER in NATURAL & SYNTHETIC FOAM

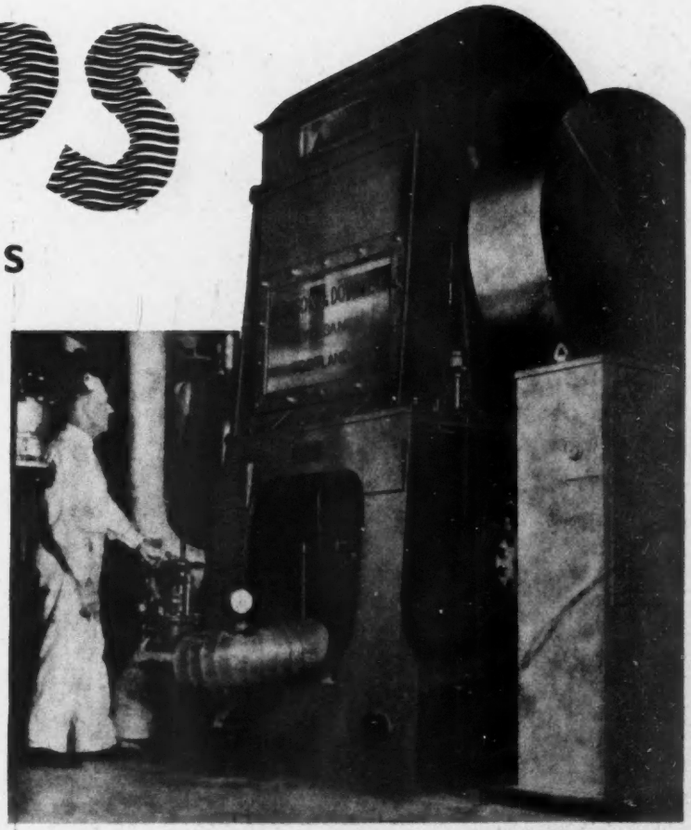
SAM KAY RUBBER CO. LTD.
HOPE MILL · PORTWOOD PLACE · STOCKPORT
TELEPHONE: STO 2617/8

RECIPROCATING

PUMPS

FOR ALL PURPOSES

The vertical high pressure Three Throw Ram Pump illustrated was supplied to Thomas Hedley & Co. Ltd. for use in the manufacture of Tide, Daz and other synthetic detergents.



BOILER FEED PUMPS
VACUUM PUMPS
OIL FUEL TRANSFER PUMPS
OIL PIPE LINE PUMPS
OIL FIELD PUMPS
OIL REFINERY PUMPS, ETC.

Dawson & Downie Ltd

ELGIN WORKS
CLYDEBANK

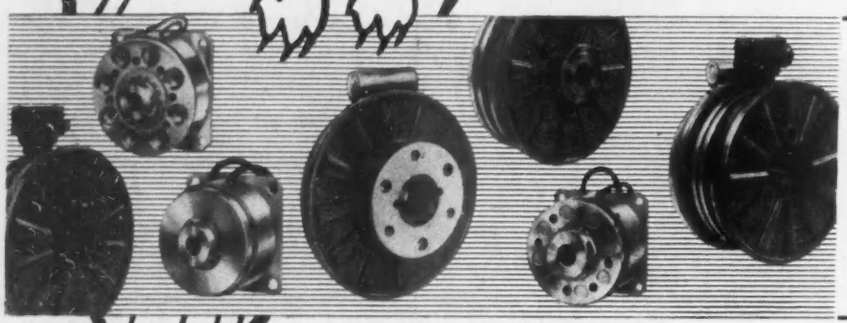
Telephone: 2271-2-3 Clydebank
Telegrams: "PUMPS" CLYDEBANK

don't be prehistoric . . .

get wise to modern methods of machinery control

If you could control rotating machine drives with split-second precision—stop and start instantaneously yet without strain—cycle, reverse and index at the touch of a button—would it not help you to attain faster, easier production? Undoutedly, and you can achieve this standard of automatic control quite simply by fitting Warner Electric Brakes and Clutches.

Designed to occupy the minimum of shaft length, these electro-magnetically actuated friction couplings can be fitted to existing machinery as easily as they can to new machines. Other advantages of Warner Electric Brakes and Clutches include automatic compensation for wear throughout the life of the unit, effective heat dissipation and absence of side or end thrust.



Write today for descriptive Warner brochure.

WESTOOL LIMITED

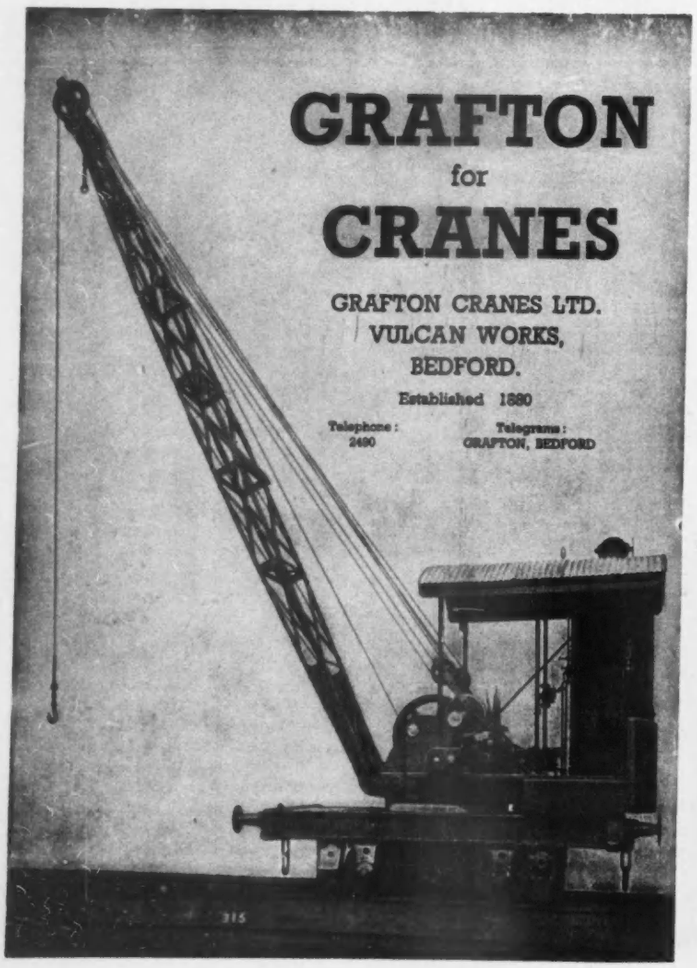
ST. HELEN'S AUCKLAND, CO. DURHAM

Phone : West Auckland 551/5
Grams: Solenoid, West Auckland

Birmingham Office : 7 Newhall Street, Birmingham 3 · Telephone : Central 3901

Westool also make : Coils & Coil Winding Machines, Transformers & Chokes, A.C. & D.C. Solenoids, Grinding Attachments, Air Conditioners, etc.

TI8.95



GRAFTON
for
CRANES

GRAFTON CRANES LTD.
VULCAN WORKS,
BEDFORD.

Established 1880

Telephone: 2490 Telegrams: GRAFTON, BEDFORD

We're losing our grip SAID THE NUT TO THE BOLT

Forget about vibration and slackness—fit a Kolok Positive Lock Washer between each nut and bolt.

We need a KOLOK Positive Lock Washer

POSITIVE LOCK WASHER CO. LTD., 45 RENFREW STREET, GLASGOW
Telephone: DOUglas 9292

ASK FOR DETAILS OF THE VARIABLE STROKE OIL VALVE

Schieldrop
PATENTED SELF PROPORTIONING
OIL BURNER

Set oil to air ratio at maximum and minimum with two adjustments only. No "trial and error."

SCHIELDROP &CO., LTD., STOTFOLD, BEDS. TEL: STOTFOLD 414 (3 lines)

SCRAP for COHEN'S

COHEN'S for SCRAP

THE 600 GROUP OF COMPANIES

GEORGE COHEN
SONS AND COMPANY LIMITED

RAW MATERIALS DIVISION

Experts in Scrap since 1834

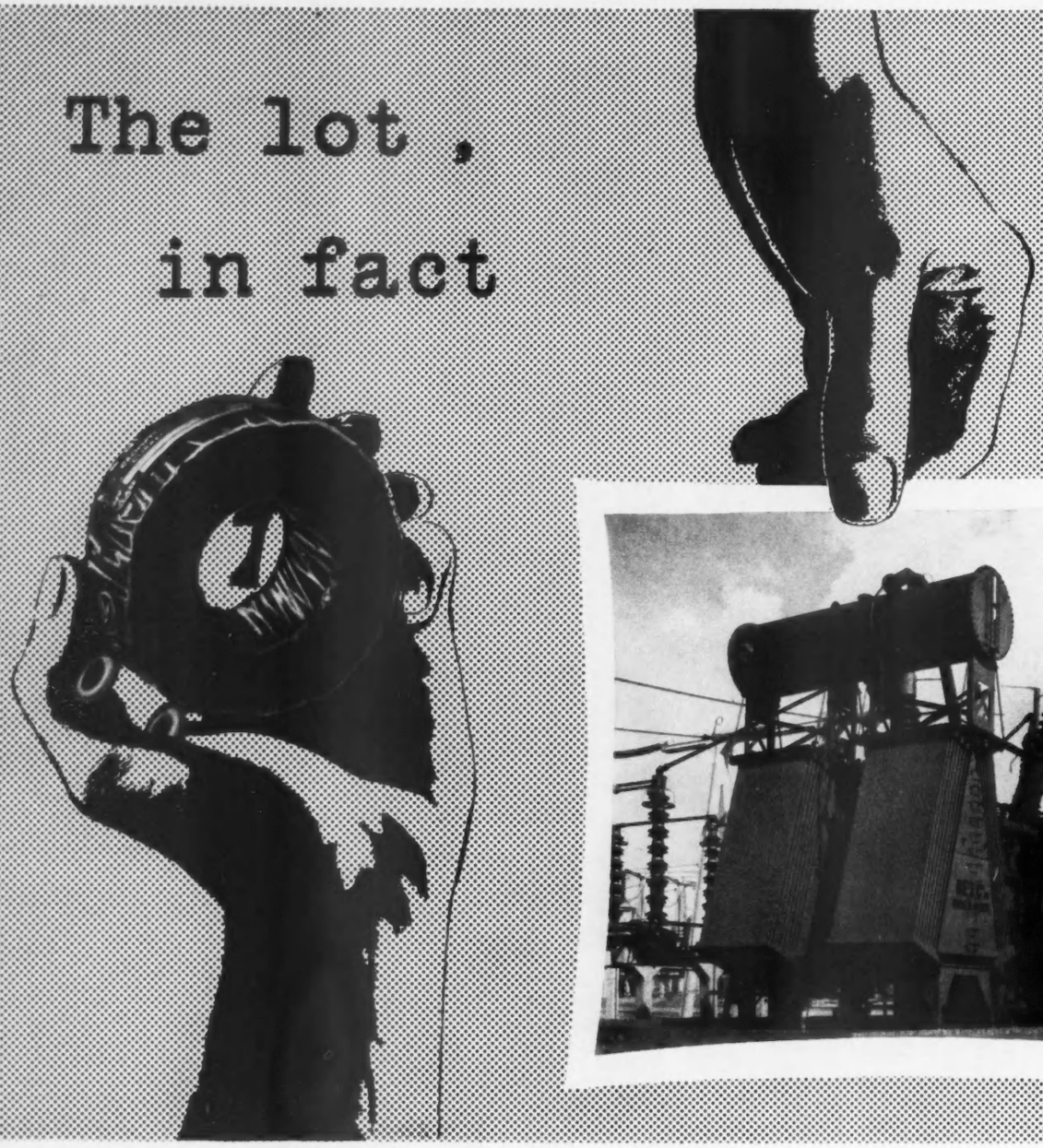
WOOD LANE, LONDON, W.12. · *Telephone:* Shepherds Bush 2070 · *Telegrams:* Coborn, Telex, London

And at 600 Commercial Road, E.14 · Bidder Street, Canning Town, E.16 · Bath · Belfast · Birmingham · Hebburn-on-Tyne · Leeds
Luton · Manchester · Sheffield · Swansea

GCS/RM

K

The lot, in fact



At Hayes we make B.E.T. transformers of all kinds — from tiny instrument transformers that are simple coils of insulated wire, impregnated and baked, to the largest Transmission and Generator transformers for voltages up to 380 kV.; with on-load tap change equipment, coolers, circulating pumps and all the rest of the paraphernalia these monsters find essential to their standard of living. Between these extremes are 5 kVA transformers for pole mounting for local distribution, transformers for an immense variety of industrial uses, with an almost equally large variety of special characteristics. Air, oil or 'Askarel' cooled transformers, and transformers with Class 'H' fire-resistant insulation. At Hayes we have facilities for testing every transformer we build—even the largest.

Crompton Parkinson LIMITED

(In association with The British Electric Transformer Co. Ltd.)

Member of the Nuclear Power Consortium:

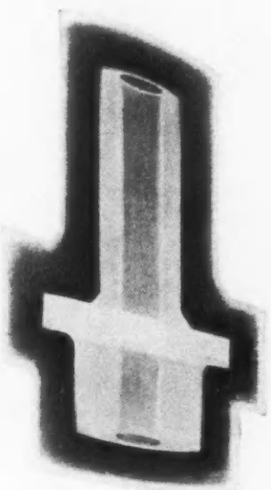
ATOMIC POWER CONSTRUCTIONS LTD.

MAKERS OF ELECTRIC MOTORS OF ALL KINDS · INSTRUMENTS
ALTERNATORS AND GENERATORS · SWITCHGEAR
B.E.T. TRANSFORMERS · CABLES · CEILING FANS
LAMPS · LIGHTING EQUIPMENT · BATTERIES
STUD WELDING EQUIPMENT · TRACTION EQUIPMENT

ELECTRICAL EQUIPMENT

CROMPTON PARKINSON LIMITED, CROMPTON HOUSE, ALDWYCH, LONDON, W.C.2

THE FOURTH DIMENSION ?



...tells all !

Space/time ? In a casting, or a forging, a tiny space unfilled will destroy, if it is not found in time. Member Companies of the Birfield Group were some of the earliest in this country to install regular X-ray examination of their products as the 4th dimensional check on the quality of their productions. Up-to-the-minute methods are part of the secret of Birfield Group success. Every Member Company of the Group is backed by the resources—manufacturing and technical—of every other company in the Group.

Forgings | for high-stress components

through the | **Birfield Group**

TWO BIRFIELD COMPANIES FAMOUS FOR FORGINGS...

FORGINGS & PRESSWORK LIMITED · WITTON · BIRMINGHAM · 6

LAYCOCK ENGINEERING LIMITED · SHEFFIELD

TAP KNOW-HOW

(yours for the asking)

Saved the Day

with a

SPEEDICUT

Our customer produces Iron Pipe fittings. Normal tap life when machine tapping was only 40/50 components. A Technical Representative from Speedicut Works studied the problem and made recommendations on design and treatment which increased tap life on this operation to over 1,500 components.

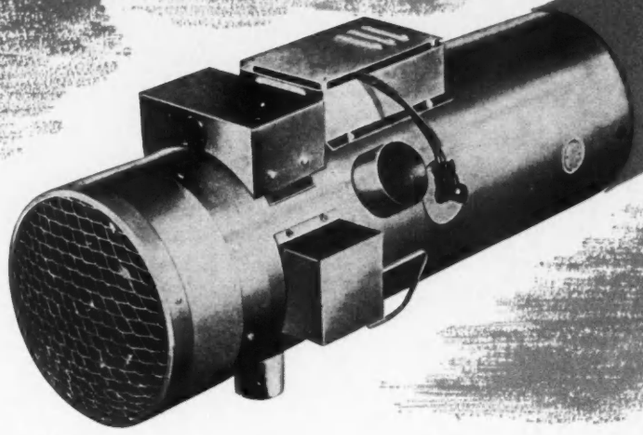
This is a typical example of how Speedicut know-how solves machining problems.

1 Tap gave
1,450 more units

F. H. BROWN TOOLS LTD. SPEEDICUT WORKS • CARLISLE ST EAST • SHEFFIELD

50,000 B.t.u. per hour from 3·3 pints of oil

10,000 cubic feet heated by a single unit



Smiths Combustion Heater can be installed in a few hours, with the minimum of structural alteration. It gives clean, controllable space heating, free from any trace of fumes, and the warmed air can be ducted to any desired areas to ensure correct distribution.

Consider these advantages:

Compact	*Measures 2' 9" x 9½"; Weight 107 lb.*
Controllable	*Automatic control by thermostat. Output also controlled at will by switch.*
Efficient	*Full heat in 4½ minutes.*
Simple	*One switch operates everything.*
Safe	*Automatic safety devices.*
Non-Toxic	*No combustion fumes circulate indoors.*
Versatile	*Gives full heat, reduced heat and also circulates cool air if required.*

Send for full illustrated folder XA.

SMITHS **50 ASM COMBUSTION HEATER**

for air comfort

Combustion Heater Department

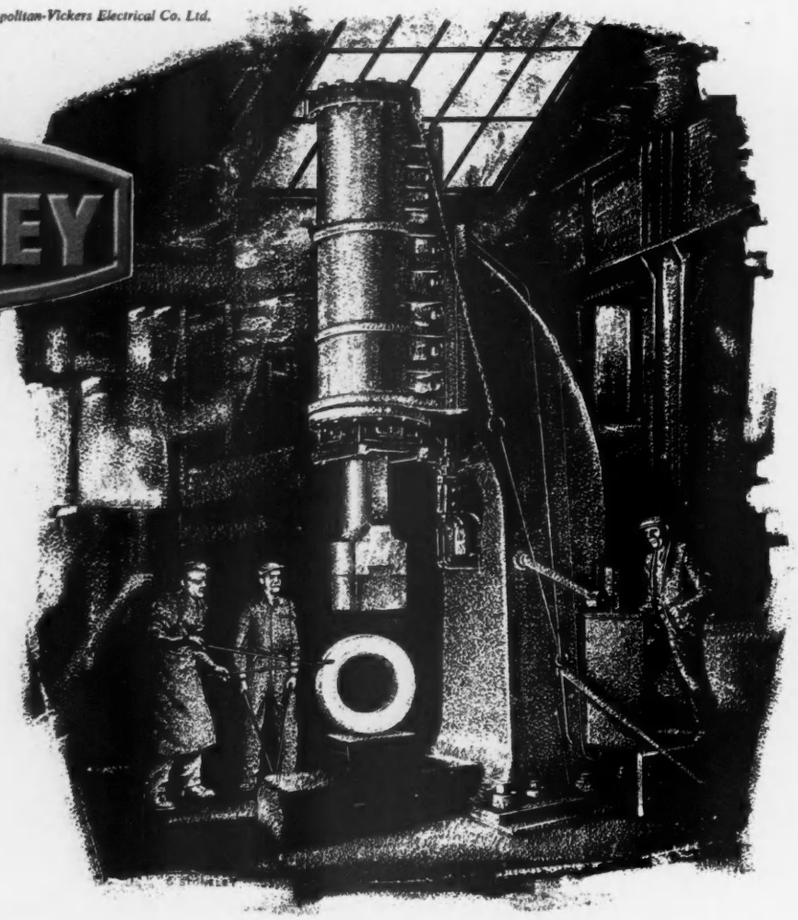
S. SMITH & SONS (ENGLAND) LTD., *Witney Sub-Division, Witney, Oxon. Telephone No.: Witney 678*

AP 230-62

4 cwt. hammer, Metropolitan-Vickers Electrical Co. Ltd.

cut costs with . . .

MASSEY



Massey " Rigby " type steam or compressed air hammers are designed to give maximum space around the anvil block for the production of intricate and awkwardly shaped forgings. Massive and powerful, with long stroke and large diameter cylinder, these hammers are easily and accurately controlled and expansion valve gear secures the maximum economy in running costs. Available in a range of sizes from 5 cwt. to 60 cwt.

Massey designs include :
Steam and Compressed Air Hammers, Pneumatic Power Hammers, Friction Drop Hammers, Double-acting Steam and Compressed Air Drop Hammers, Forging Presses, Trimming Presses, Tyre Fixing Rolls.

B. & S. MASSEY LTD.

OPENSHAW, MANCHESTER, ENGLAND

MAKERS OF THE WORLD'S GREATEST RANGE OF FORGING PLANT

Unique

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatique than bolts or studs made by the usual method.

C. P. Newall & Co., Ltd.

POSSILPARK · GLASGOW · N.

They treat me like a V.I.P.

"That's the best of dealing with a medium-sized firm like Johnson & Phillips. To them every customer is a Very Important Person."

"And is given personal service?"

"Exactly. J. & P. still retain the traditions of a family firm. It's a delightful humanizing trait in an efficient modern organisation."

"I always knew J. & P. were efficient. I'm glad they're human too."

"It's a pleasure to do business with them."

THE RIGHT-SIZED FIRM FOR YOU

J. & P. manufacture cables, transformers, switchgear, capacitors, etc., and undertake electrification schemes for many of the largest industrial concerns in this country and overseas.

They have been in the business since 1875. But they still retain that regard for the individual customer that only the smaller firms can have.

JOHNSON & PHILLIPS

A Power in the Electrical World

JOHNSON & PHILLIPS LTD., CHARLTON, LONDON, S.E.7

How does a bridge move? —on MEEHANITE

Bridge constructed for the Cumbran Development Corporation. Chief Engineer, Lt/Col A. Borlase, T.D., M.I.C.E., M.I.Mun.E.—Contractors, Ernest C. Jordan & Son Ltd., Newport.

One of the bearing plates, which are cast with the beams, with its complementary bed plate, which is cast into the concrete abutment. Meehanite castings by Goulds Foundries Ltd., Newport.

Cast Iron Can Do it-if it's

MEEHANITE

The Dependable Metal

MEEHANITE METAL FOUNDRIES AT YOUR SERVICE

The Bellshill Company Limited, Ripley, Clarke Cameron and Robertson Limited, Kirkintilloch, Carmichael Bros. (Airdrie) Ltd., Alex Brown, Sons Limited, Goulds Foundries Limited, Newport, Mon., John Harper (Manchester) Limited, Wilmslow, Sale, G. H. Hay and Company Limited, Glasgow, C. A. Parsons and Company Ltd., Newcastle-upon-Tyne 6, Qualcast (Derby Part) Ltd., London W.5, Richards Foundries Limited, Leicester, Southern Foundries Ltd., Weldon, Croydon, Surrey, Stewart Smelting, Rochester, Sidmore, Bowen, Pease and Co., Sunderland, Tyne.

THE INTERNATIONAL MEEHANITE METAL COMPANY LIMITED

Meehanite House, 4 Downside, Epsom, Surrey Tel: Epsom 2507/8 Telegrams: Meehan, Epsom

EVEN a stationary bridge is a mechanism, expanding and contracting with temperature, flexing with the weight of heavy traffic. Meehanite cast bearing plates running on rollers, or sliding on Meehanite bed plates, accommodate this constant movement.

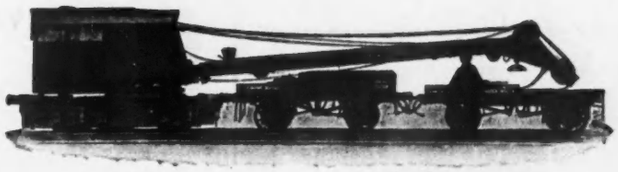
Meehanite castings are being widely specified by civil and consulting engineers for this work because of their outstanding compression strength and their excellent resistance to wear and distortion.

There are actually 26 types of Meehanite iron. Each possesses a different combination of physical properties—among them toughness, high strength, uniform solidity, and anti-friction qualities—to cover the many purposes for which iron castings may be used.

Your nearest Meehanite foundry will be glad to send you a copy of the booklet 'Meehanite in the Service of Industry', or write to the address opposite.

TAB/1357

T&H FOR CRANES



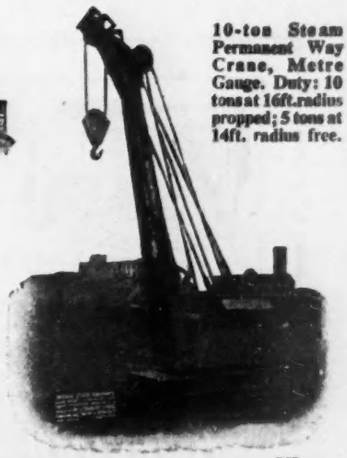
10-ton Diesel Permanent Way Shunting Crane in train formation.

4-TON DIESEL SHUNTING CRANE, permanent way pattern, supplied to British Railways.

STEAM ELECTRIC DIESEL
DIESEL-ELECTRIC CRANES

TAYLOR & HUBBARD

Telegraphic Address: "Lifting, Leicester" Telephone Nos.: 22575–6



10-ton Steam Permanent Way Crane, Metre Gauge. Duty: 10 tons at 16ft. radius propped; 5 tons at 14ft. radius free.

P37

MALLEABLE IRON CASTINGS

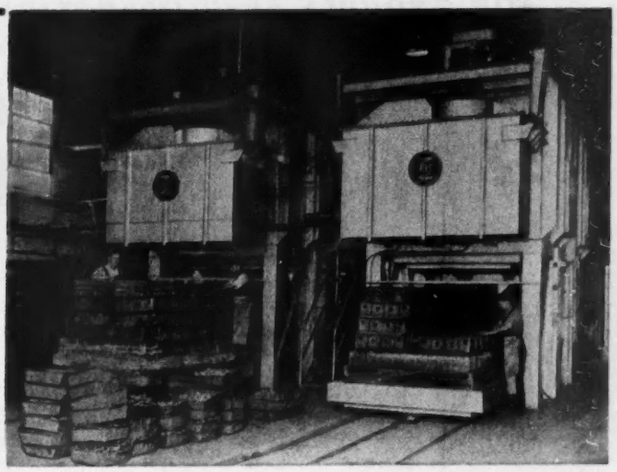
ANNEALED IN THE MOST MODERN GASEOUS DECARBURISING PLANT

Excellent Physical Properties

From:

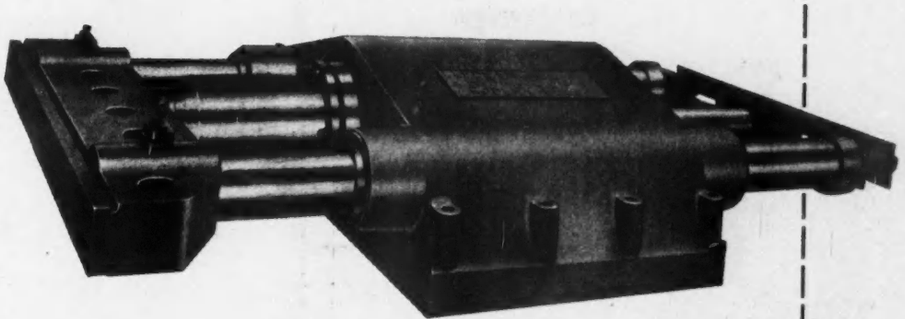
PLATT MALLEABLE CASTINGS LTD.

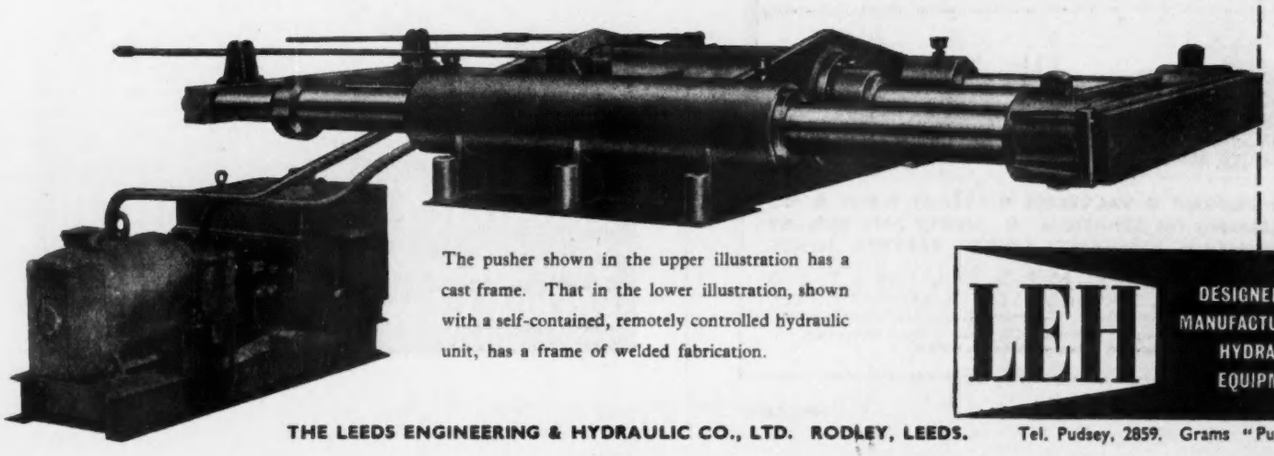
CLIVE FOUNDRY · LEAMORE · WALSALL



LEH FURNACE PUSHERS

Typical of robust L.E.H. design, these hydraulic furnace pushers are ideally suited to steelworks duty where unfailing reliability under arduous conditions is of prime importance.



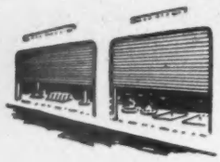


The pusher shown in the upper illustration has a cast frame. That in the lower illustration, shown with a self-contained, remotely controlled hydraulic unit, has a frame of welded fabrication.

LEH DESIGNERS AND MANUFACTURERS OF HYDRAULIC EQUIPMENT

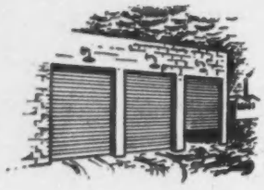
THE LEEDS ENGINEERING & HYDRAULIC CO., LTD. RODLEY, LEEDS. Tel. Pudsey, 2859. Grams "Pumps," Rodley.

LOADING BAYS
Shutters for everyday use - designed to give good closure and long life.



CANTEEN COUNTERS
Shutters and grilles for bars and counters designed with an eye to appearance.

KINNEAR SHUTTERS
FOR TROUBLE-FREE OPERATION



FACTORY ENTRANCES
Shutters giving complete weather protection, easy operation; single doors or in series.

Write for informative literature to Dept. 7B.

ARTHUR L. GIBSON & CO. LTD
TWICKENHAM, MIDDLESEX.
TEL. POPESGROVE 2276 BIRMINGHAM HIGHBURY 2804
GLASGOW HALFWAY 2928 MANCHESTER CENTRAL 1008

POSITIVE REMOTE CONTROL
AT YOUR FINGER TIPS

Wherever the application of an efficient positive remote control system is required the ARMSTRONG Unit provides a simple, effective answer. Easy to install, rust-proof, permanently self-lubricated and temperature corrected, neither the 'Slave' nor 'Master' units need maintenance. Amongst innumerable applications, flue damper controls, built in systems for Machinery Controls and Motions, remote gear shift operations, jig latching and valve control, etc., are typical.

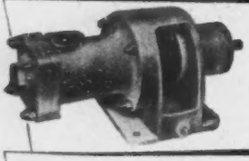
Full information gladly supplied.

ARMSTRONG
Regd. Trade Mark
REMOTE CONTROL UNIT

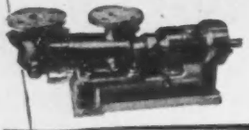
ARMSTRONG PATENTS COMPANY LIMITED
EASTGATE · BEVERLEY · YORKSHIRE

The **MONO pump**

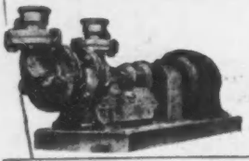
FOR INDUSTRIAL PUMPING



THE "B" RANGE
A small 60 G.P.H. Pump ideal for dispensing or Pilot Plant duties.



THE "H" RANGE
Constructed in stainless steel or gunmetal for food and chemical applications.



THE "D" RANGE
Made in cast-iron for general industrial use.

SELF PRIMING ● VALVELESS ● STEADY FLOW ● NO CHURNING OR AERATION ● SIMPLE AND ROBUST ● UNIFORM EFFICIENCY UNDER VARYING HEADS

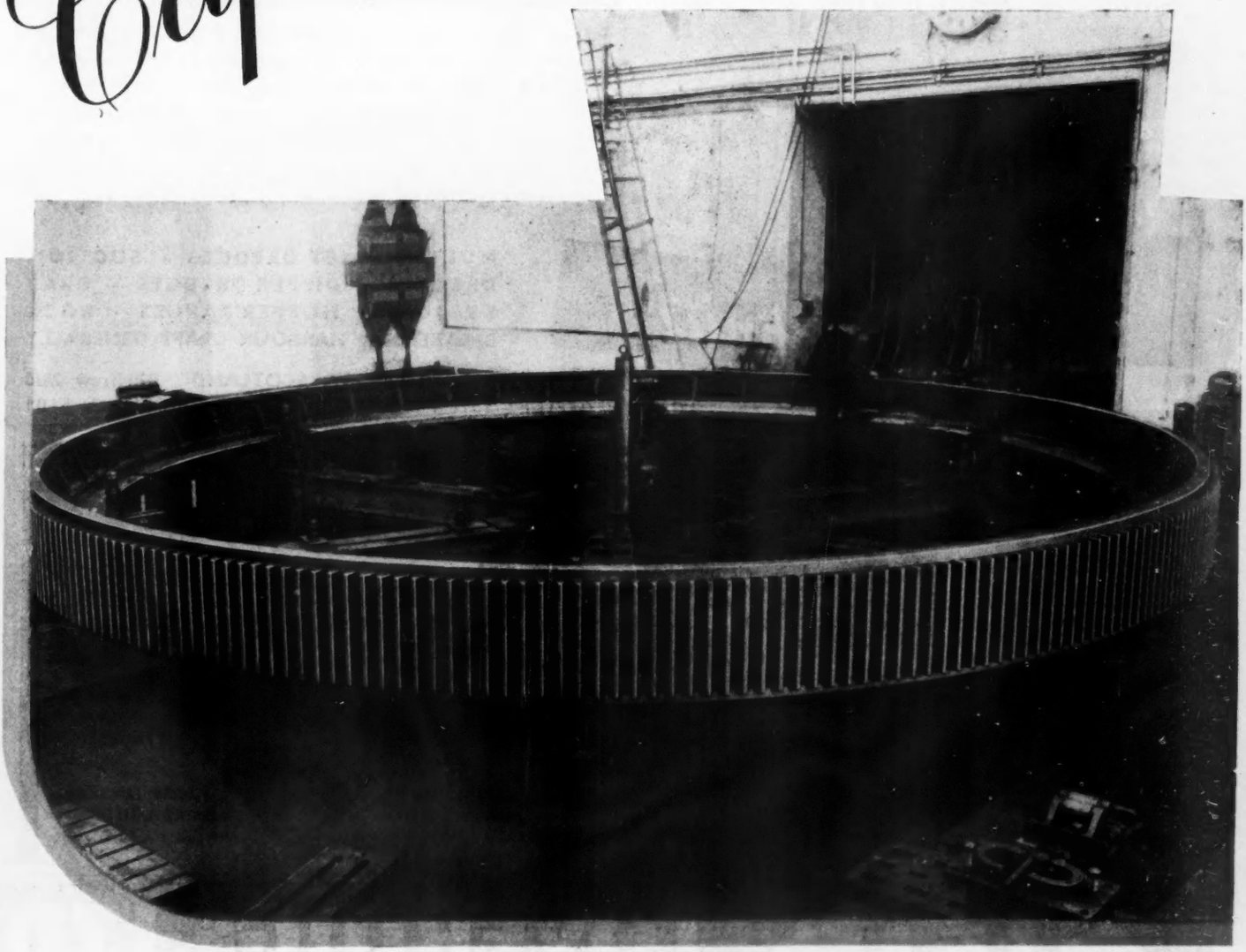
MONO PUMPS LIMITED
MONO HOUSE, SEKFORDE STREET, LONDON, E.C.1.
Telephone: Clerkenwell 8911 Telegrams: Monopumps, Phone London
and at Belfast, Birmingham, Capetown, Dublin, Durban, Glasgow, Johannesburg, Manchester, Melbourne, Newcastle, Wakefield

MP227/L4196

BROADBENT & CO. (ROCHDALE) LTD.
Grove Spring Works, LINCOLN STREET,
ROCHDALE, Lancs. *Phone: Rochdale 4628-9*

Capacity!

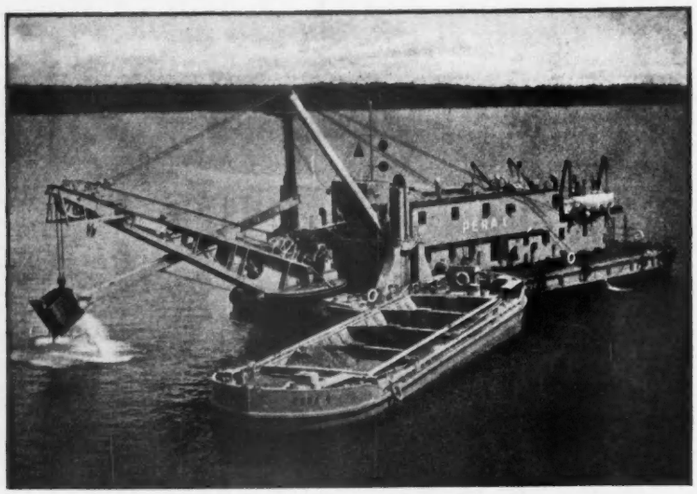
Our unique steel foundry and machine shops are specially equipped for the production of Spur, Helical or Bevel Gears, either machine cut or machine moulded, of the largest sizes. 'Jackson' gears are in constant world-wide use in all heavy industries — why not consult us and take advantage of over a century's technical experience.



Cutting 26ft. Dia. spur ring on 30ft. machine.

THE
DAVID BROWN
CORPORATION (SALES) LIMITED
JACKSON DIVISION
SALFORD WORKS HAMPSON STREET
MANCHESTER 5

Keeping things clear in Finland . . . . . .



This is 'Pera I' which was recently built by Lobnitz for work in Finnish Waters. It is an electrically operated 4 cubic yard dipper dredge, of the non-propelling type.

Lobnitz are internationally famous wherever there is a battle against mud and silt. Their long experience of the world's waterways is at your service and the technical staff are always available for consultation.

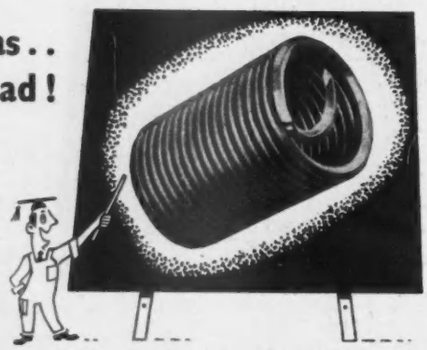
Lobnitz THE NAME TO REMEMBER IN DREDGING

MULTI-BUCKET DREDGES · SUCTION DREDGES · DIPPER DREDGES · GRAB DREDGES · HOPPER BARGES · ROCK BREAKERS · HARBOUR CRAFT GENERALLY

LOBNITZ & CO., LTD., RENFREW, SCOTLAND RENfrew 2216
LONDON OFFICE: 55/61 MOORGATE E.C.2. MONarch 5101

It's as simple as.. Fit your thread!

Hard tough threads in soft materials—new threads for old in damaged components. Used and approved by the Aircraft Industry—designed for use in soft metal components, wood or plastics. Simple to use, remains permanently in place. Full range of standard sizes in B.S.W.: B.S.F.: B.S.P.: B.A. U.N.F.: U.N.C. and Metric thread forms.



Cross WIRE THREAD INSERTS

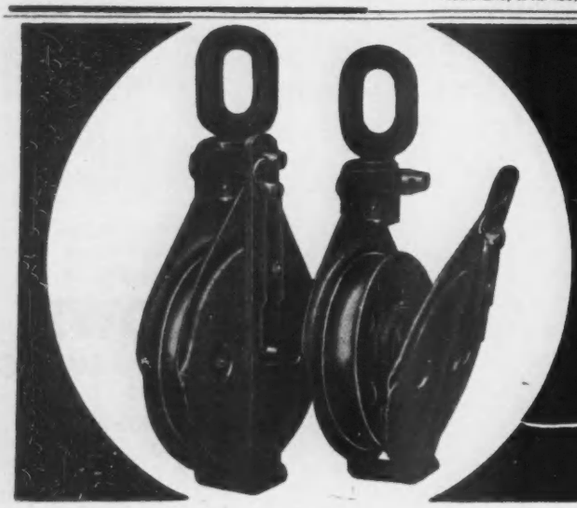
CROSS MANUFACTURING CO. (1938) LTD. · BATH·SOMERSET.
Tel: Combe Down 2355-8 Grams: Circle, Bath.
SPECIALISTS IN THE MANUFACTURE OF JET ENGINE LABYRINTHS, CIRCLIPS, SPRING WASHERS, SPRINGS, ETC.

Forgings

IN IRON & STEEL UP TO 1½ CWTS.

GEORGE MILLS (ENGINEERS) LTD. Established 1920
214-218 RAVENSCROFT RD., BECKENHAM, KENT. Telephone: SYDenham 5255

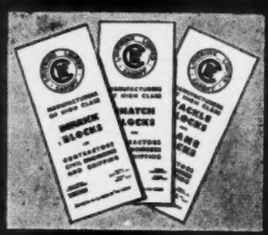
A.I.D. APPROVED
A.R.B. APPROVED
PROTOTYPES AND SPECIAL PURPOSE MACHINES
HEAVY AND "AWKWARD" MACHINING & GRINDING
REPAIRS & SALVAGE BY METAL DEPOSITION IN STELLITE, CHROME, NICKEL Etc.
WELDING FABRICATING PROFILE FLAME CUTTING AND GENERAL PRESSWORK



LOVERIDGE LTD

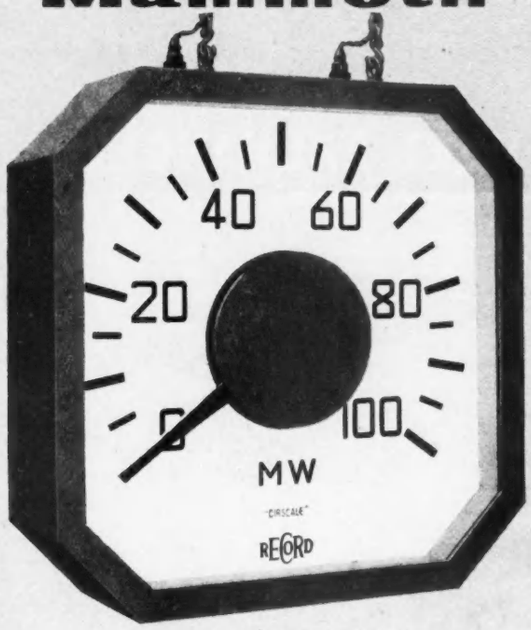
151-153 BUTE STREET, DOCKS, CARDIFF

Manufacturers of Patent
SNATCH BLOCKS
also PULLEY BLOCKS and
CRANE BLOCKS
for Wire Rope



Telephone: CARDIFF 23641 Send for Brochures

Mammoth



"Cirscale"

With a scale length of 5 feet, bold figures and internal illumination, this instrument can be read accurately at considerable distances. It complies fully with BSS 89/1954 and combines ample power with high sensitivity. It is suitable for indicating Amps, Milliamps, Volts, R.P.M. or Frequency, or any value which may be converted into one of these. Single or double sided models available

by RECORD

THE RECORD ELECTRICAL CO. LTD · 'CIRSCALE' WORKS · BROADHEATH · ALTRINCHAM · CHESHIRE

©9125/-

The Niagara in action

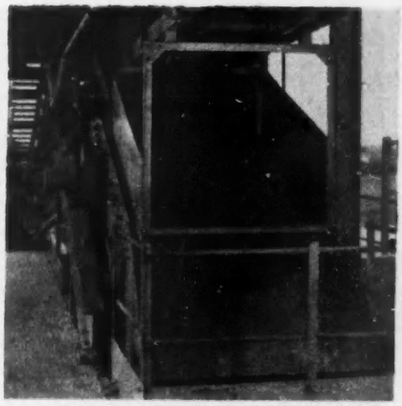


Photo by courtesy of Tothill Press Ltd.

The
PROOF
OF A SCREEN
lies in its efficiency

Here is a Niagara Vibratory Screen at work continuously delivering an accurately graded, clean, washed product exactly to specification. It is pleasing its owners by the quality of its output and by its economic costings. It is working here on a large stationary plant, handling gravel under water sprays, but, whatever the duty, the Niagara Vibratory Screen operates with the highest possible standard of grading efficiency.

Phone : ENFIELD 6622 (4 lines)

NIAGARA SCREENS
(Gt. Britain) LTD.
Straysfield Road, Clay Hill, Enfield, Middlesex

MAKE LIGHT OF THAT
Heavy Duty

Equip with KING DICK

Precision-made under carefully controlled conditions, KING DICK Hand Tools set a superlative standard for Heavy Engineering work.

Please send for fully illustrated catalogue which will give you complete details of our range of hand tools.

BUY KING DICK BRITISH

ABINGDON KING DICK

HAND TOOLS

ABINGDON WORKS · KINGS ROAD
TYSELEY · · BIRMINGHAM, 11

HEAVY DUTY RING SPANNERS
A formidable tool when used in conjunction with our special tubular handles.

OPED ENDED PODGER SPANNERS
In B.S., B.S.W., American, A/F and Unified Hex. Sizes.

SLOGGING RING SPANNERS
Available in B.S., Whitworth, American, A/F, and Unified Hex. Sizes to suit all requirements.

FLAT 7½° SLOGGING RING SPANNER
In B.S., B.S.W., American, A/F and Unified Hex. Sizes.

PODGER ENDED SOLID BOX SPANNERS
In B.S., B.S.W., American, A/F and Unified Hex. Sizes.

RING PODGER SPANNERS
A heavy-duty tool supplied in all sizes to meet your requirements.

OPEN ENDED PODGER SPANNERS (Flat 15°)
Forged in Chrome Vanadium Steel to withstand the hardest work.

POWER OPERATED SOCKETS
For assembly lines, heavy engineering and Hicycle Tools. In ⅜", ½", ¾", 1", 1½" and 2½" Square Drive.

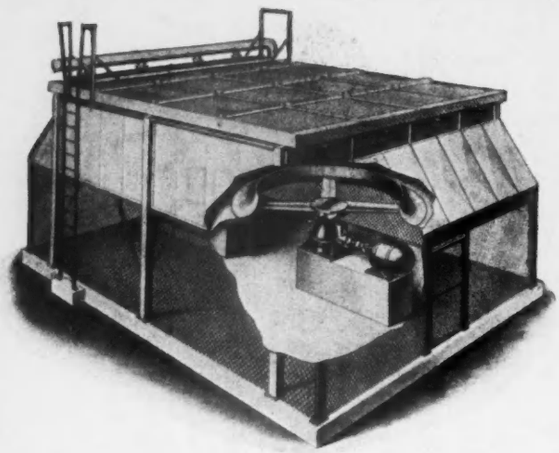
RE 200/3

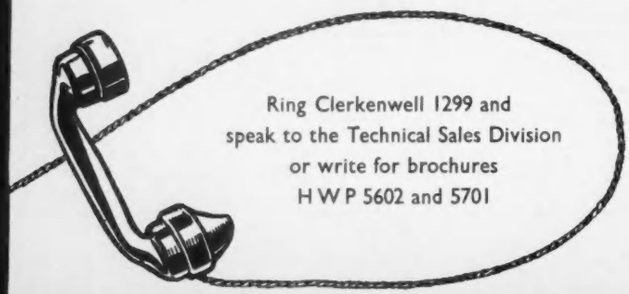
FIN-FAN

AIR COOLED HEAT EXCHANGERS

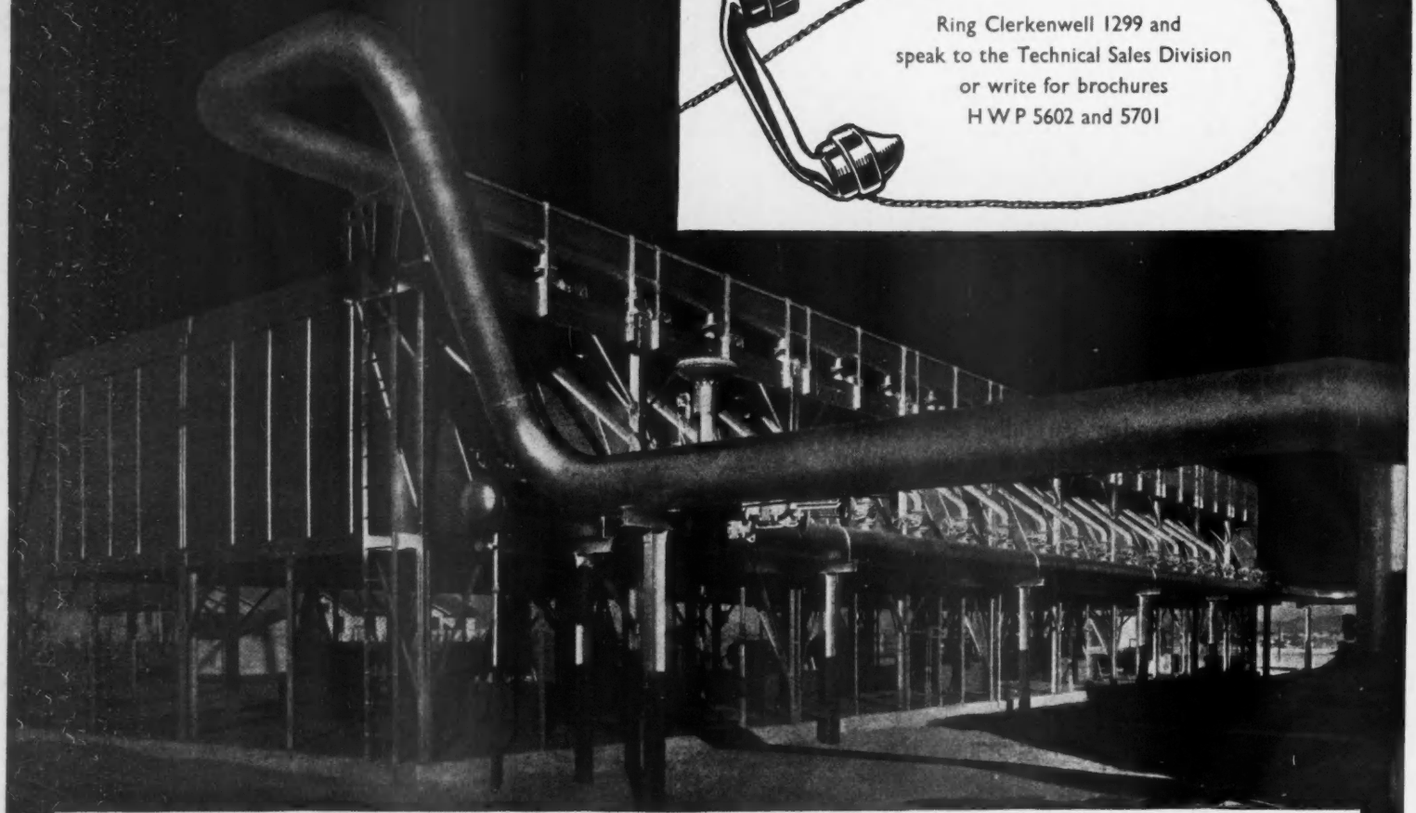
provide guaranteed temperature control and economic operation

The simple and robust construction of the fin-fan, which is made up of a minimum number of standardised parts, combines appearance with utility. These forced draught coolers are powered by electric motors, gas or diesel engines, steam turbines, etc., using adjustable pitch propeller type fans, and can be employed in a great variety of waste heat dissipation duties at pressures from vacuum to 5,000 p.s.i. or temperatures to 1,500° F.





Ring Clerkenwell 1299 and
speak to the Technical Sales Division
or write for brochures
H W P 5602 and 5701



HEAD WRIGHTSON PROCESSES LTD

TEESDALE HOUSE · 24/26 BALTIC STREET · LONDON · EC1

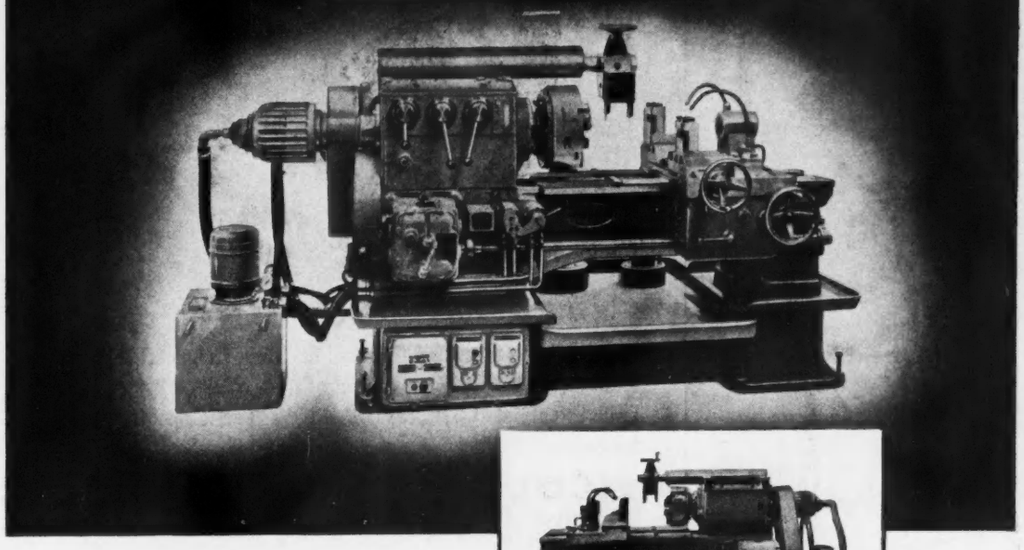
OFFICES AT: P.O. Box 1595 **SYDNEY** · P.O. Box 1034 **JOHANNESBURG** · P.O. Box 2608 **CALCUTTA** and 603 Royal Bank Buildings **TORONTO 1**

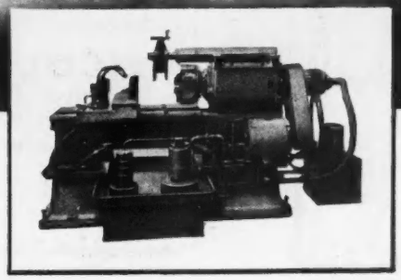
Associates in the U.S.A.: The Fluor Products Company · Los Angeles 22 · New York · Chicago · Tulsa, etc.

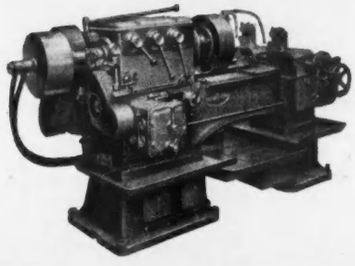
P3294

CROWTHORN

8½" CENTRE
PARTING-OFF
TURNING & BORING LATHE







This lathe is specially designed for the high speed production of such articles as cylinder liners, piston rings, etc., and for the rapid parting-off of ferrous and non-ferrous bar and tube. The specification includes pneumatic or hydraulic chucking equipment, screw operated parting-off toolslide assembly on overhead arm, front and rear tool holders, boring bar holder, self contained motor drive and electric suds pumps. Please write for detailed literature.

CROWTHORN ENGINEERING COMPANY LIMITED
High Class Machine Tool Makers
REDDISH · STOCKPORT · ENGLAND
Phone: STOCKPORT 7271-2-3 *Grams: CROWTOOL, REDDISH*

CL92

Anderton

WRITE FOR DATA SHEETS TO DEPT. A.7

Cyril Circlip's STOCK ranges from 1/16" to 15"

ANDERTON SPRINGS LTD., BINGLEY
Tel.: 2388, 2351 & 2236
Grams: CIRCLIPS, BINGLEY

A.I.D., A.R.B., I.F.V. approved

CIRCLIPS

VOLTAGE STABILIZERS

By F. A. Benson, M. Eng., A.I.M.E.E., M.I.R.E., University of Sheffield

Price 12/6

This monograph describes the various devices employing saturated elements, glow-discharge tube circuits and thermionic valve arrangements for voltage stabilization. A comprehensive bibliography is included.

Order your copy through your bookseller or direct from:

ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C.2.

The Engineer

BUYERS GUIDE 1958

Now Available

CONTENTS

Associations, Institutions and Societies connected with the Engineering Industry.

Address Section.

U.K. Agents for Foreign Firms.

Trade Names.

Buyers Guide.
32,000 Suppliers' entries under 2,300 product headings.

Forthcoming Engineering & Industrial Exhibitions.

One free copy has been sent to every postal subscriber to 'THE ENGINEER' and every regular reader who buys his copy from a newsagent.

A copy has also been sent to each advertiser in 'THE ENGINEER' and the BUYERS GUIDE itself.

Additional copies obtainable at 7/6 each (plus postage 1/9) from :—

The Manager—
THE ENGINEER
28, ESSEX STREET, STRAND, LONDON, W.C.2
CENtral 6565

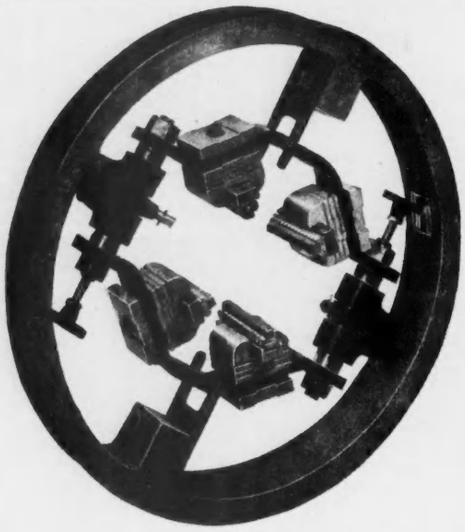
but we tailor in stainless steel

Made to measure jobs are our speciality. Vats, vessels and machine parts in heat-resisting and corrosion-resisting materials—particularly stainless steel and nickel alloys are usually problems, but they're problems we take on every day of the year. Our technical department is always available for consultation, advice and service. Call us in and see what a difference superb stainless steel tailoring makes.

for instance . . .
Stainless steel tipping container

WELDING TECHNICAL SERVICES LTD.,
ENGINEERS AND FABRICATORS
HURST MILL, KINGS NORTON, BIRMINGHAM 30

PHONE: KINGS NORTON 2360/2555. GRAMS: WELTEXA BIRMINGHAM

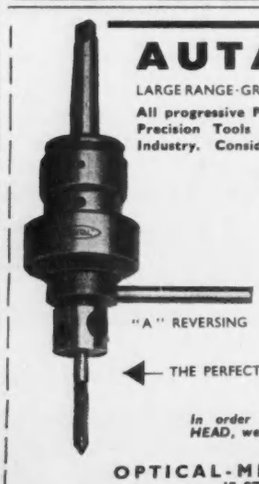


EXTERNAL GRINDING HEAD

Grinding and Honing of shafts including Cranked Shafts with accuracy of ·001/2" and super finish of 8-10 micro inches. The External Grinding Head is available in sizes of diameters from 4" to 48".

NICOL & ANDREW LIMITED
HILLINGTON, GLASGOW S.W.2. Tel: HALfway 4724
LONDON OFFICE: 172 HIGH STREET, BRENTFORD, MIDDLESEX

AGENTS: Walter C. Hill & Co. Ltd., King Sq. Ave., Stokes Croft, Bristol 2.	Bristol 28264
Hinchcliffe & Partners, 6 Park Grove, Cardiff.	Cardiff 29719
Elson, Margetts & Co. Ltd., 8 Queen's Rd., Coventry.	Coventry 2469
A. F. Richardson, Metalock (Britain) Ltd., 61 Church St., Grimsby.	Grimsby 56499
Metalock (Britain) Ltd., Room 28, 3rd Floor, Exchange Bdgs., Quayside, Newcastle-on-Tyne.	Newcastle 24808
J. Hamilton & Co. Ltd., 102 and 104 Percy St., Belfast.	Belfast 29798



AUTAL TAPPING HEADS
(Patented in Germany)

LARGE RANGE · GREATER PRECISION · LOWER COST · EVEN LESS SCRAP

All progressive Production Engineers should now consider these Precision Tools which are in increasing demand throughout Industry. Consider these various features:-

- High speed geared reverse
- Infinitely variable torque
- Tap breakage eliminated
- No special Collets
- Five reversing and four non-reversing models giving:-
- Tap range from 12BA to 1¼"
- "B" Type suitable also for Capstans

"A" REVERSING

"B" NON-REVERSING

THE PERFECT COMBINATION

"OPTIMEC" HSS/GROUND THREAD TAPS

In order to demonstrate our confidence in this TAPPING HEAD, we offer you one without obligation for 7 days trial

Sole distributors to U.K.

OPTICAL-MECHANICAL (Instruments) LTD.
17 STATION ROAD, EGHAM, SURREY
Tel: EGHAM 3120

Valves, Cocks & pipe line fittings from Stock

PEGLER & LOUDEN LTD

54 BROWN STREET	113 NEW BRIDGE STREET	87 SHAW STREET
GLASGOW	NEWCASTLE	LIVERPOOL

PRIMERS

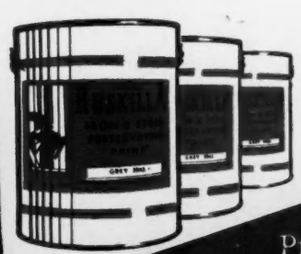
UNDERCOATS

FINISHES

... TOGETHER PROVIDE

POSITIVE PROTECTION

FOR IRON AND STEEL



Practical experience dictates 3-coat treatment for the protection of new steelwork or where rusted metal must be bared. For your new constructions and for your maintenance programme, specify "Atlas" Ruskilla Paints throughout. Remember, every coat—Primers, Undercoats and Finishes—is truly rust inhibiting, durable and dependable! Send today for shade-card to—
ATLAS PRESERVATIVE CO. LTD., ERITH, KENT.
Telephone: ERITH 2255.

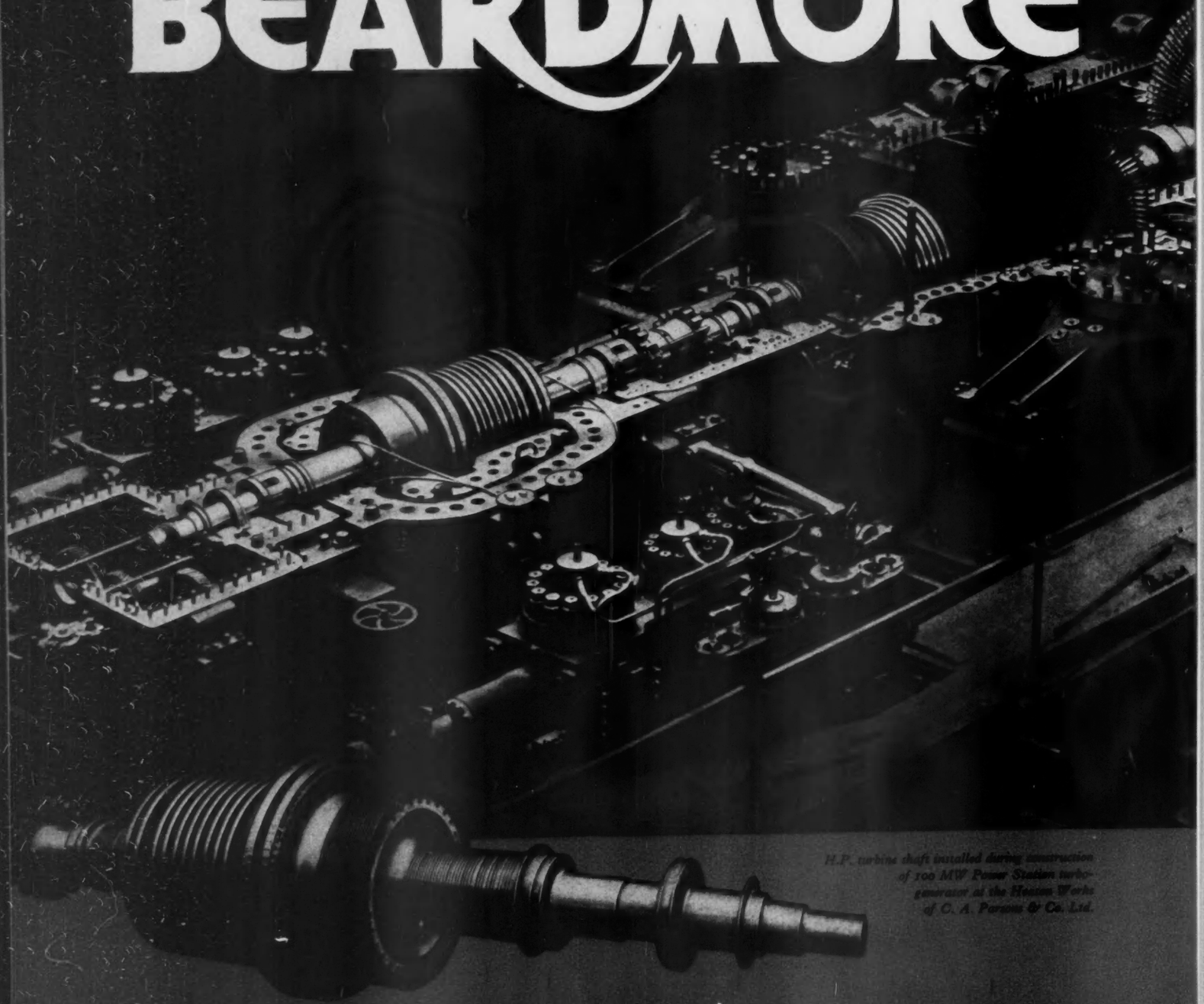
ATLAS RUSKILLA

The Paints of Stamina

ATLAS PRESERVATIVE

REG' TRADE MARK

BEARDMORE



H.P. turbine shaft installed during construction of 100 MW Power Station turbo-generator at the Heaton Works of C. A. Parsons & Co. Ltd.

forgings and castings in carbon and alloy steels for electrical and general engineering purposes

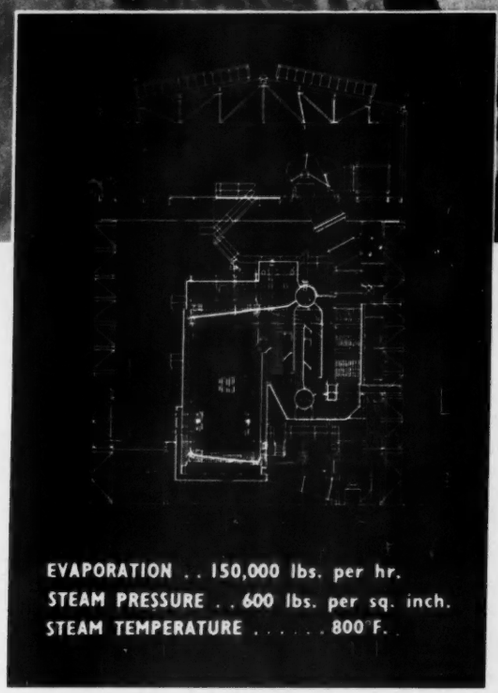
WILLIAM BEARDMORE & CO. LIMITED

PARKHEAD STEEL WORKS · GLASGOW E1

11 Hamilton Place, Piccadilly (Hyde Park Corner), London, W.1 and 2 St. John Street, Manchester, 3

BEARDMORE INDUSTRIAL COMPONENTS

Forgings and castings in carbon and alloy steels: boiler drums, railway carriage and wagon axles, heavy components and thermal shielding for nuclear power stations, armaments and complete machining facilities.

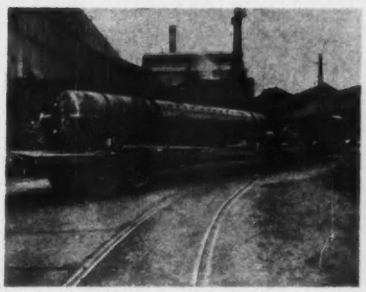


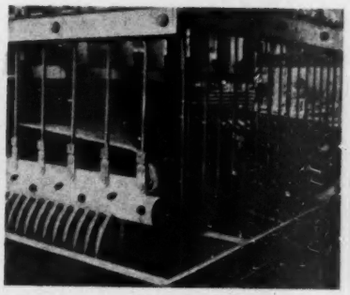
EVAPORATION . . 150,000 lbs. per hr.
STEAM PRESSURE . . 600 lbs. per sq. inch.
STEAM TEMPERATURE . . . . . 800°F.

OIL FIRED BOILERS for Thames Board Mills Ltd.

LARGEST MANUFACTURERS OF BOARD IN THE BRITISH ISLES

TWO BI-DRUM radiant heat oil-fired units are being installed in the Warrington Mill of the above Company, additional to two coal-fired boilers already supplied. The boilers have fusion welded drums, superheater economiser and balanced draught plant and integral de-superheater for steam temperature control, together with fully automatic boiler control. The contract includes oil-firing equipment, main steam, feed and blow-down pipework.



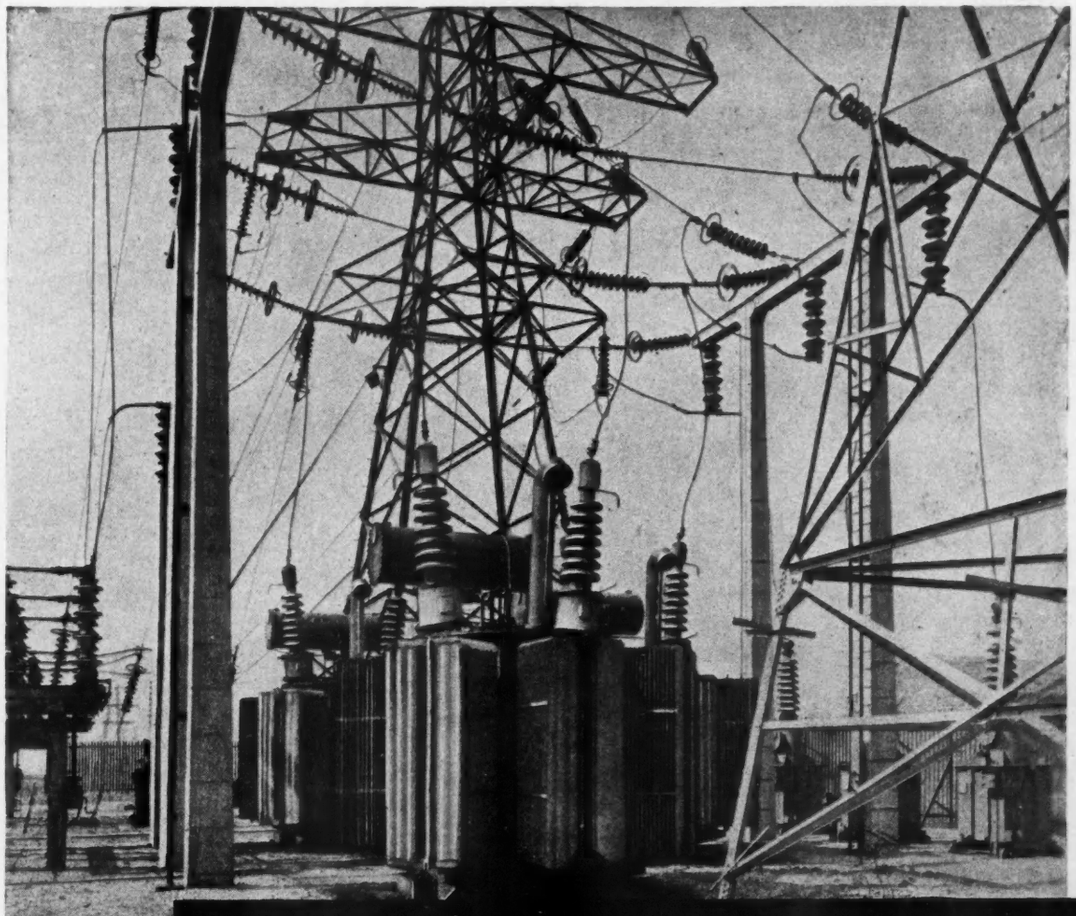


Clarke Chapman

STEAM GENERATING PLANT

CLARKE, CHAPMAN & CO. LTD., VICTORIA WORKS, GATESHEAD, 8, CO. DURHAM. London Office: DUNSTER HOUSE, MARK LANE, E.C.3.
Glasgow Office: 116 HOPE STREET, GLASGOW, C.2. Manchester Office: 8 KING STREET, C.2.

WESTON OIL SEALS



Coreless Shielded **REACTORS**

Group of three single-phase reactors for a 90-MVA 132-kV Power link at a British Grid substation.

Three of 91 single-phase reactors for a 15-MVA 33-kV system at a power station in Australia

- **limit short-circuit currents**
- **maintain stability**
- **effect economies in switchgear**

These simple and robust METROVICK oil-immersed units are used extensively on power station busbars, and transmission and distribution systems. Unlike the core-type reactors which may reach saturation at higher currents, Metropolitan-Vickers coreless reactors have a straight line volt/ampere characteristic up to their maximum short-circuit rating.

Both single and three-phase types are supplied to cover a very wide range of current ratings.

* *Please write for descriptive* ***leaflet*** **379/1-1**

METROPOLITAN-VICKERS

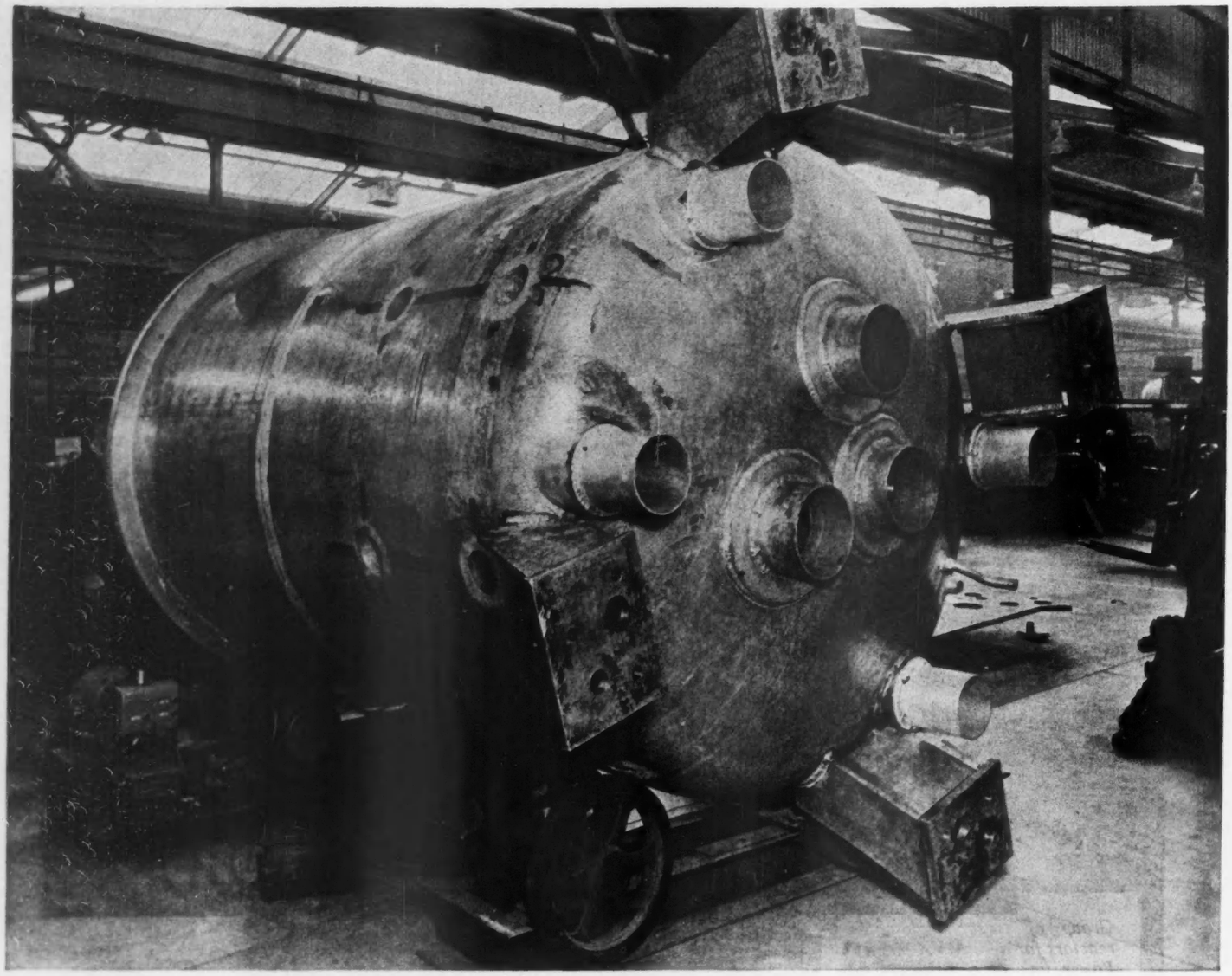
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

An A.E.I. Company

Leading Electrical Progress

E/A 501

M



British Aluminium
in the Atomic Energy field

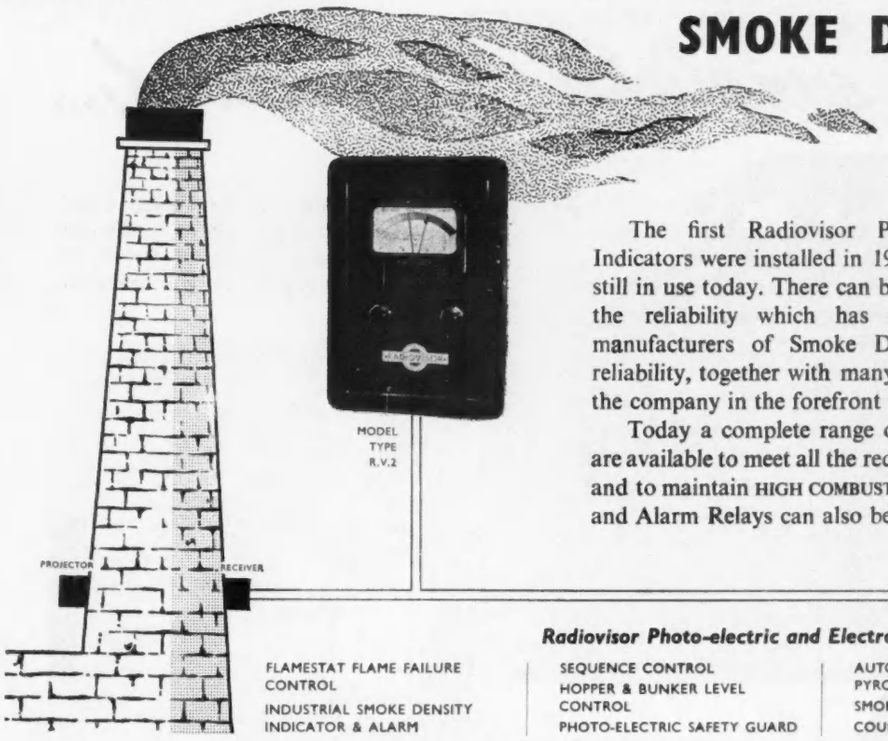
This "DIDO" Reactor Core Tank which contains the aluminium clad fuel elements and the heavy water moderator, is constructed from 99.8% purity aluminium. It was fabricated by The A.P.V. Co. Ltd., to the order of Head Wrightson Processes and is one of four being built for installation in research reactors to be used by the British and Australian Atomic Energy Authorities for high flux testing and the production of radio-isotopes.

The BRITISH ALUMINIUM Co Ltd

NORFOLK HOUSE ST JAMES'S SQUARE LONDON SW1

AP51

SMOKE DENSITY INDICATOR AND RECORDER



The first Radiovisor Photo-Electric Smoke Density Indicators were installed in 1931 and these original units are still in use today. There can be no better acknowledgement to the reliability which has made Radiovisor the largest manufacturers of Smoke Density Equipment; and this reliability, together with many years of experience, is keeping the company in the forefront of progress.

Today a complete range of inexpensive Radiovisor units are available to meet all the requirements of the CLEAN AIR BILL and to maintain HIGH COMBUSTION EFFICIENCY. Chart recorders and Alarm Relays can also be supplied.

Radiovisor Photo-electric and Electronic controls include:

FLAMESTAT FLAME FAILURE CONTROL
INDUSTRIAL SMOKE DENSITY INDICATOR & ALARM

SEQUENCE CONTROL
HOPPER & BUNKER LEVEL CONTROL
PHOTO-ELECTRIC SAFETY GUARD

AUTOMATIC RADIATION PYROSTAT
SMOKE DETECTOR FIRE ALARM
COUNTING & BATCHING UNIT

TURBIDITY EQUIPMENT
PRINT REGISTRATION
FACTORY LIGHTING CONTROL
AUTOMATIC DOOR OPENING

Please address your enquiries to the SALES DIRECTOR

RADIOVISOR PARENT LIMITED

STANHOPE WORKS · HIGH PATH · LONDON · S.W.19

Telephone: *CHErrywood 3351 *Telegrams:* Radivisor London S.W.19

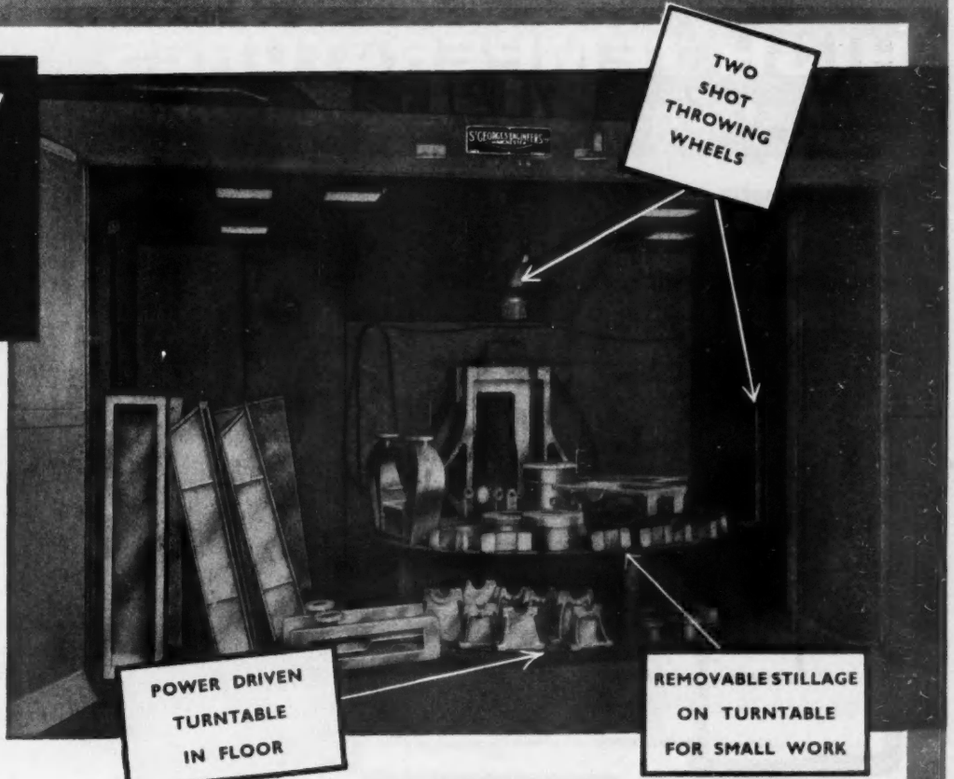
RADIOVISOR EST. 1927

'UNIVERSAL' WHEEL BLAST ROOM PLANT
14'0" x 10'0" x 8'6"

comprising

TWO SHOT THROWING WHEELS WITH PRESSURE NOZZLE FOR SPECIAL WORK

Made for **MESSRS. HEENAN AND FROUDE LTD. OF WORCESTER,** this plant is designed to accommodate all types of miscellaneous castings, welded fabricated work, and large steel tanks.



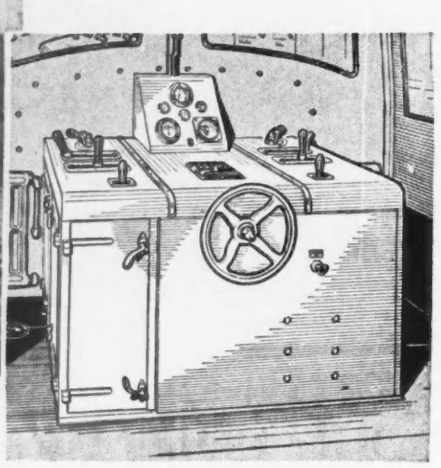
ST. GEORGES ENGINEERS LTD.

ORDSALL LANE, MANCHESTER 5

Telephone: TRAfford Park 1207 (4 lines) *Telegrams:* "Georgic" Manchester 5

for simplicity... of control...

The controls of the Peckett Diesel Locomotive are easy to handle—no special manipulation of throttle or clutch is required for gear changing.



PECKETT *diesels*

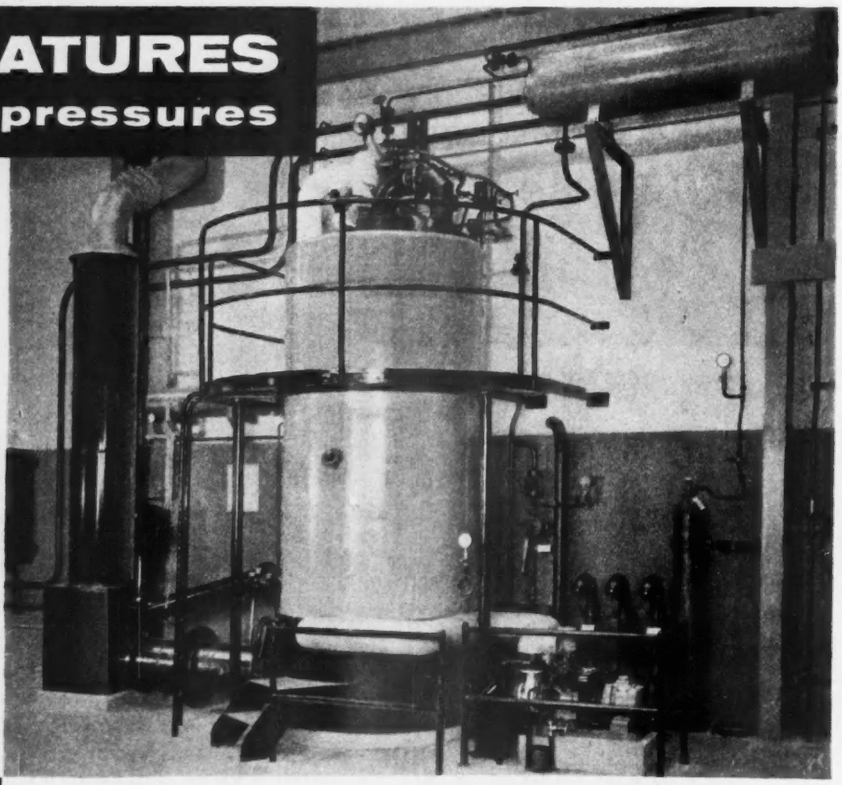
The various control levers have been carefully grouped for maximum convenience and are duplicated on either side of the control desk. In conjunction with the extraordinary all-round vision from the fully-enclosed cab, this simplicity greatly minimizes fatigue and mental distraction, and ensure the fullest output from driver and locomotive.

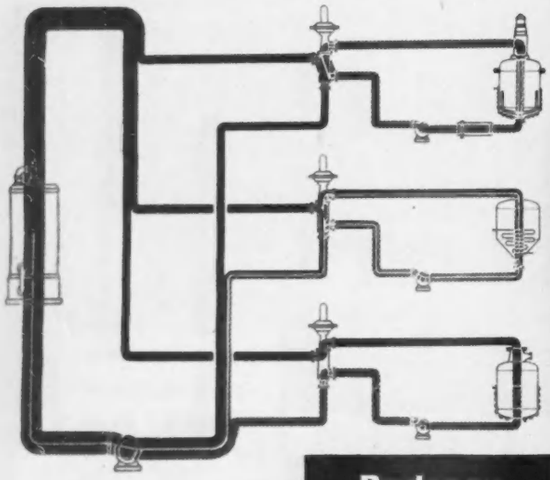
London Representatives:
Ferguson & Palmer, 9 Victoria Street, Westminster S.W.1.

PECKETT & SONS LIMITED, ATLAS LOCOMOTIVE WORKS, ST. GEORGE, BRISTOL 5. Tel: 65-5346. 'Grams: "Peckett" Bristol

HIGH TEMPERATURES
at extremely low pressures

With automatic control of several vessels at varying temperatures up to 700° F. from one boiler with liquid medium.





Flow diagram illustrates use of unique 4-way valve to give cooling: intermediate or maximum temperatures.

Bertrams ROSEDOWNS System

High Temperature Heating Plants

ROSE, DOWNS AND THOMPSON LIMITED
OLD FOUNDRY, HULL. Telephone 33874. London office:- 39, Victoria Street, S.W.1. Telephone ABBey 2496
MEMBER OF THE POWER-GAS GROUP.

Stop Burning One in Ten!

Have a look at your power bill — and then consider your plant. Are you *sure* you are getting the most out of your transmission — or are inefficient drives frittering away the kilowatts which should be helping production?

As power costs increase efficiency matters more than ever — fit the only drive with a National Physical Laboratory Certificate confirming 98½% mechanical efficiency and get the power you pay for.

RENOLD high-efficiency drives cut your overheads

. . . Since 1947 electricity charges have almost doubled.
. . . Look at these figures from a typical factory :—

1947 £2·925 per 1,000 Units
1957 £4·9 per 1,000 Units

By making the most efficient use of power RENOLD CHAIN DRIVES are an effective counter to this cost spiral and can offset these and any future increases by as much as 10% — and go on doing so year after year.

RENOLD

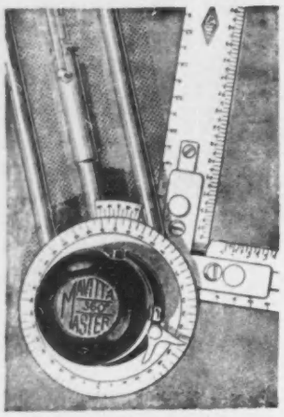
—the FIRST name in precision chain

RENOLD CHAIN LIMITED · MANCHESTER

MAVITTA

DRAFTING MACHINES

A complete range of Drafting Machines for Boards up to 50 feet long, both vertical and horizontal.
Adjustable Drawing Stands and Boards.
Mathematical Scales in various materials.
Surveyor's Rods.
Isometric Projection Machines.



THE MASTER—latest in our range—Linkage by steel bands and pulleys—360 degrees rotation of index head—automatic location of main angles by press button through knob—quick release of head for lining up to drawings — counterbalanced for vertical use—modern styling and high quality finish.

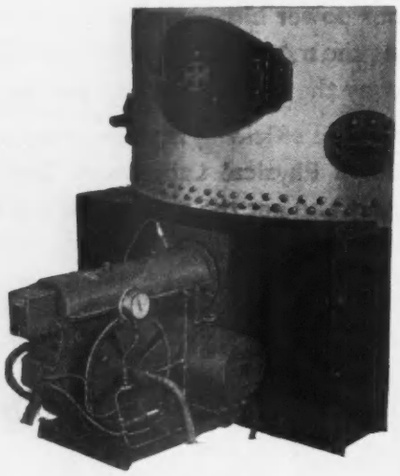
FULL CATALOGUE ON APPLICATION

The MAVITTA DRAFTING MACHINES LTD.
HIGHLANDS ROAD · SHIRLEY · BIRMINGHAM
Phone : SOLIHULL 2231/2 Grams : Mavitta, B'ham

M1

PRIOROIL BURNERS

Available in ten sizes for heat outputs of 50,000 to 4,000,000 BTUs/HR for use with light, 200 or 950 seconds oil, depending on capacity.



'SH' model burner applied to a 6' 6" diameter and 15' 9" high Cochran Steam Boiler, which is fired with a combustion efficiency of 84%.

- *efficient*
- *reliable*
- *economical*
- *clean*
- *smokeless*
- *labour-saving*
- *backed by the best after-sales service*

PRIOR
STOKERS LIMITED

MANUFACTURERS OF OIL BURNERS AND UNDERFEED STOKERS

1/3 BRANDON ROAD, LONDON, N.7. TEL: NORTH 2245/8
50 WELLINGTON ST., GLASGOW, C.2. TEL: CENTRAL 5323/4
and at BIRMINGHAM · BRISTOL · CARDIFF · LEEDS · LEICESTER LIVERPOOL · NEWCASTLE

. . . . ring Plannair . . . . tell them what you have in mind and your air movement problems are over. Plannair blowers—power for size the most effective of their kind in the world—have proved themselves outstanding in both the electronic and aircraft fields for applications involving either cooling or heating. And now, design engineers and manufacturers engaged in electrical and engineering practice have in this superb 8" Plannair blower a new force with which to tackle their air movement problems. Technical data is given below. This blower and others in the Plannair range, together with this company's special ability in matters of air movement may be of considerable help to you. In that event, all you have to do is—get on to the blower: Leatherhead 4091.

PLANNAIR BLOWER 8PL141-257

Blade tip diameter of impeller 8½"

Volumetric airflow 750 c.f.m. at a maximum pressure rise of 1.5" w.g.

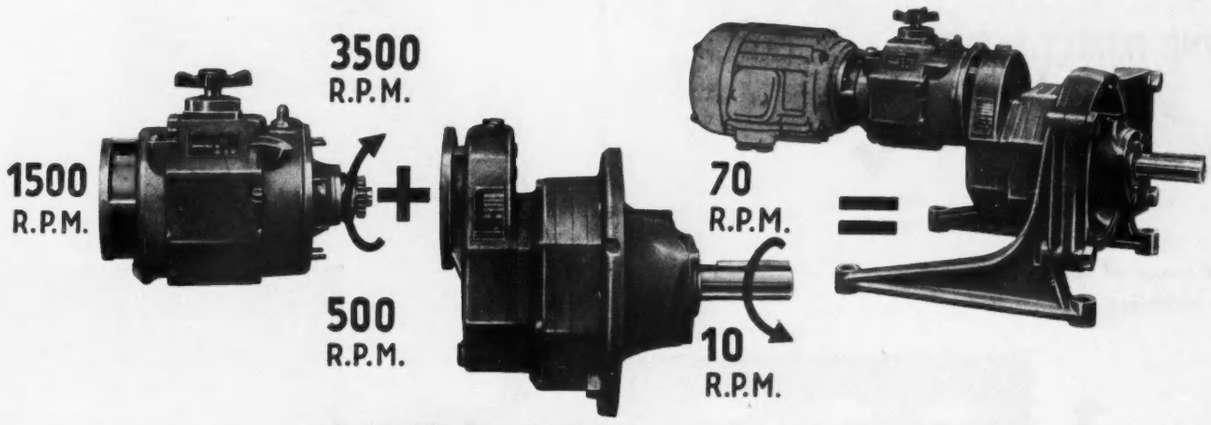
230 v. single phase 50c capacitor type 2,800 r.p.m.

PLANNAIR

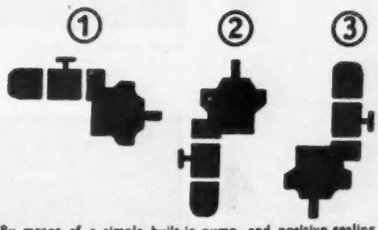
PLANNAIR LIMITED · WINDFIELD HOUSE · LEATHERHEAD · SURREY

PLA11c

AN IDEAL SOLUTION TO ANY VARIABLE SPEED PROBLEM



one of the SADIVAR STANDARD COMBINATIONS



As an ideal solution to any variable speed problem—one of the SADIVAR standard combinations—such as that illustrated above offers a number of major advantages.
A seven to one speed range is obtained at any speed level by incorporating to the Sadivar one or more mass produced high efficiency planetary gears whose torque characteristics correspond to that of the machine to be motorized.

SPEED STABILITY — IMMEDIATE DELIVERY

By means of a simple built-in pump, and positive sealing arrangement, Sadivars can be supplied for either of the three positions illustrated above.

Agents in all Commonwealth Countries and most countries in the world. Agents in Eire:—A. C. E. C. IRELAND LTD., Dublin.

SADI ENGINEERING CO. LTD.

10-14 ANSDELL STREET, KENSINGTON SQUARE, LONDON, W.8. Telephone: Western 7653 Cables: Sadiunit, London

SPECIFY **"REAVELL"**

FOR EFFICIENCY AND RELIABILITY

RECIPROCATING COMPRESSORS
ROTARY COMPRESSORS
TURBO COMPRESSORS

PRESSURES FROM
1 TO 10,000
LBS. PER SQ. INCH

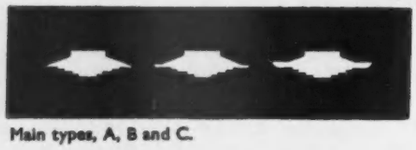
FOR AIR, HYDROGEN, OXYGEN, NITROGEN, AND OTHER GASES.

REAVELL & CO. LTD.
IPSWICH, ENGLAND
Telegrams: "REAVELL" Ipswich Telephone: Ipswich 56124 (3 lines).

THE FAIRITT SERIES

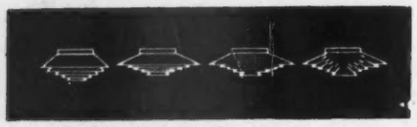
Our range of Air Diffusers includes:

3



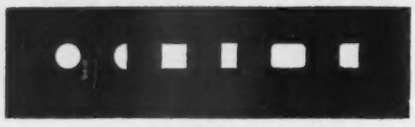
Main types, A, B and C.

4



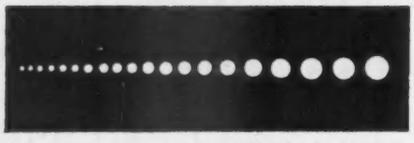
Variations, High level, Low level, etc.

6



Different Shapes, Round, Square, Rectangular and Half Round, Half Square, and Half Rectangular.

20



Different Sizes for most types, shapes and variations.

making a range of more than

2000

different diffusers.

In addition there are two kinds of dampers, and an airsplitter and damper available for most sizes, two kinds of metal are available and three different finishes for 300 different colours; and, what is more, we are constantly adding to this range.

Send for Catalogue No. 21.

FAIRITT ENGINEERING CO. LTD.

AIRMASTER

101 Sandford Road, Moseley, Birmingham, 13
'Phone: South 3651

604 Grand Buildings, Trafalgar Square, London, W.C.2
'Phone: Whitehall 4805

If it hasn't – *it isn't*

It isn't a genuine *Jubilee* CLIP
Regd. Trade Mark

Famous in Four Reigns

L. ROBINSON & CO. (GILLINGHAM) LTD., LONDON CHAMBERS, GILLINGHAM KENT., TELEPHONE 5282

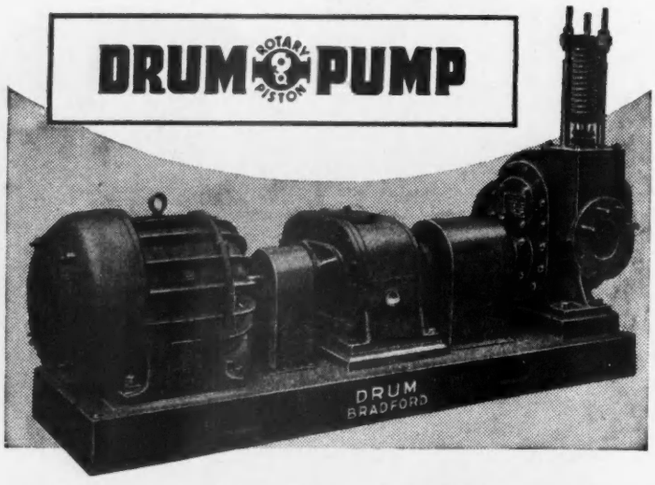
PUMPS
for the
PETROLEUM INDUSTRY

Below: Motor driven Oil Transfer Pump; 50 tons/hr.

150 to 100,000 g.p.h.; temperatures up to 600° F.

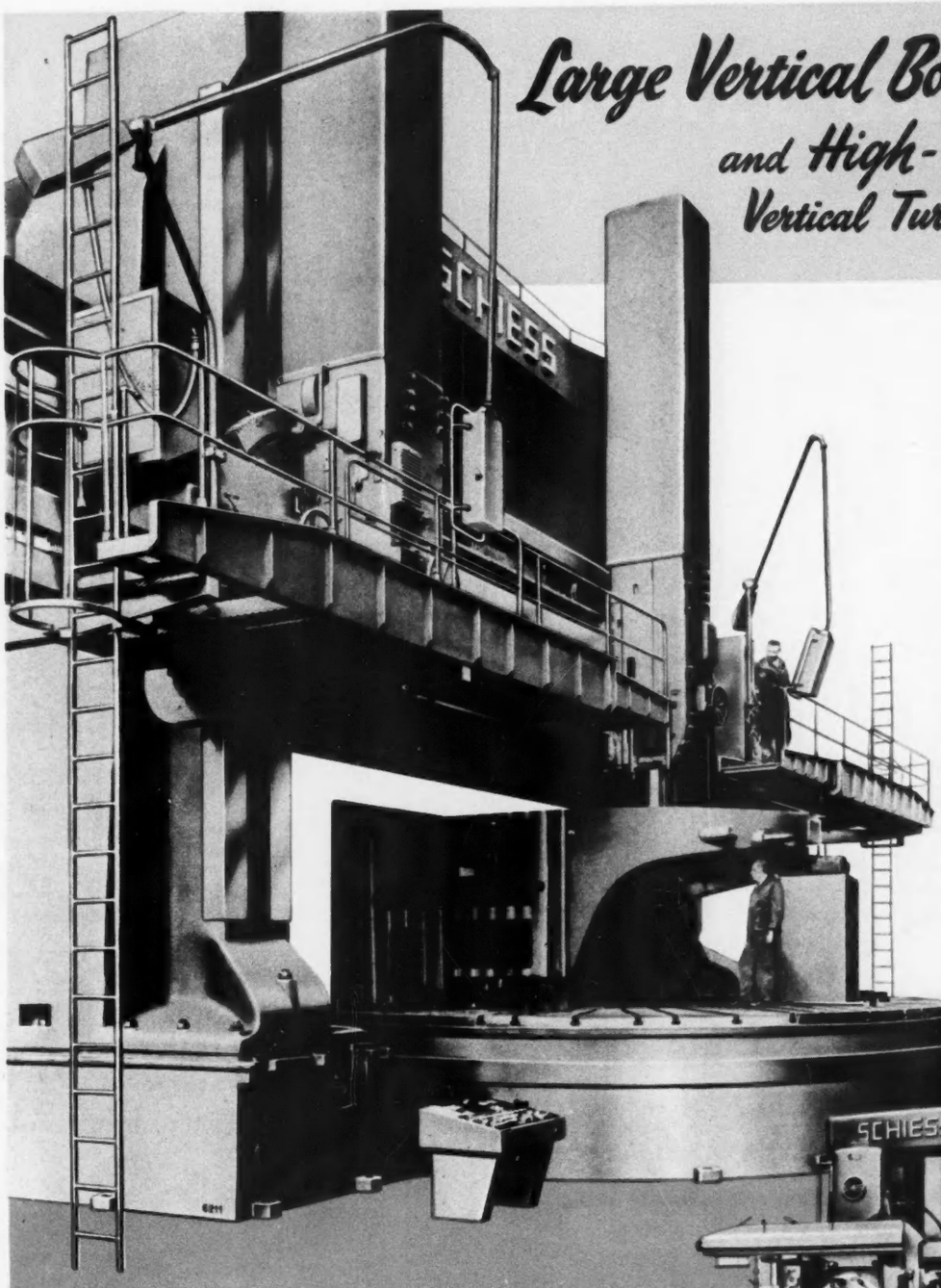
DRUM Pumps meet the requirements of the petroleum industry in a unique way and are suitable for liquids from the most volatile to the most viscous, over a wide range of temperatures. Cargo, bunkering, transfer, road tanker, refuelling pumps, etc.

DRUM ROTARY PISTON PUMP



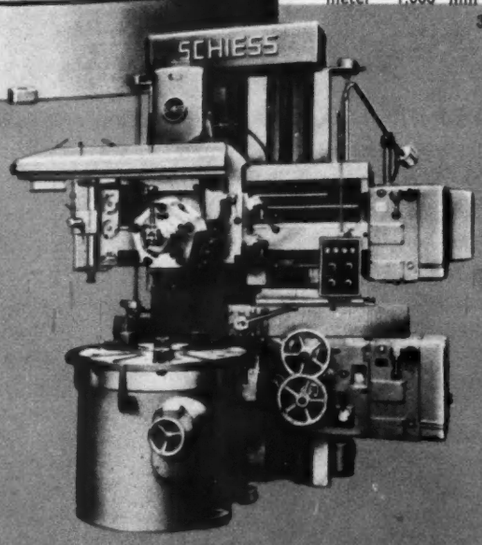
THE DRUM ENGINEERING COMPANY LIMITED.
HUMBOLDT STREET, BRADFORD. TELEPHONE: BRADFORD 22358
London Office:
38, Victoria Street, Westminster, S.W.1 Telephone: ABBey 3961
Branch Offices in Glasgow, Newcastle, Manchester and Birmingham.
DR46

Large Vertical Boring Mill and High-Speed Vertical Turret Lathe



Double-column vertical boring mill with double work table. Maximum turning diameter 10 m or 32 ft. 10 in.

Single-column high-speed vertical turret lathe. Maximum turning diameter 1,000 mm or 39 in.



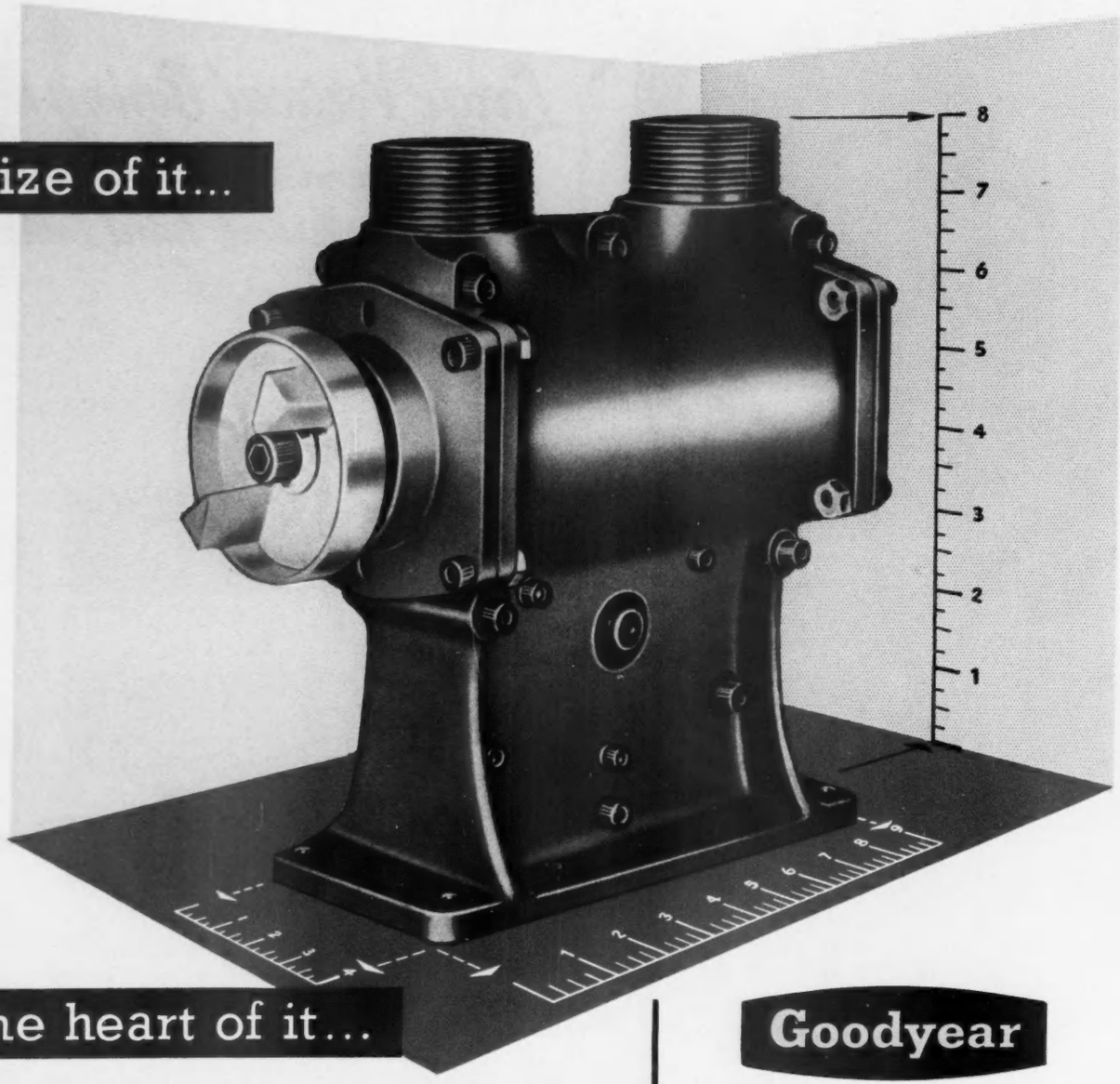
We supply Vertical Boring Mills of up-to-date design in all sizes and types to meet every requirement

SCHIESS AKTIENGESELLSCHAFT DÜSSELDORF

Sole Agents United Kingdom and Eire, **BURTON, GRIFFITHS & CO. LTD. BIRMINGHAM**

N

the size of it...



and the heart of it...

e.g. 30 galls. per min. at 200ft. head

GOODYEAR is a continuous self-priming, self-lubricating pump incorporating a unique screw engaging with a rotating plate to produce a pulseless action that is completely positive. All engaging surfaces are rubber-to-metal, fluid-lubricated—reducing frictional losses to an absolute minimum—resulting in unusual efficiency and long life. *The GOODYEAR pump, exceptionally compact, robust and efficient, will readily perform the duties usually assigned to much larger pumps.*

Goodyear

All-purpose pump range

	ins.	mm.
Overall Height		
With Relief Valve	10	254
Without Relief Valve	8	203
Maximum width	4	102
Maximum length	9	229

Weight 20 lb. (9 kgs.)

★ Unequalled suction. Self-priming. Self-lubricating. Will run on "snore" indefinitely. Made in Light Alloy for portable units, Meehanite for process pumping and Bronze for marine work.

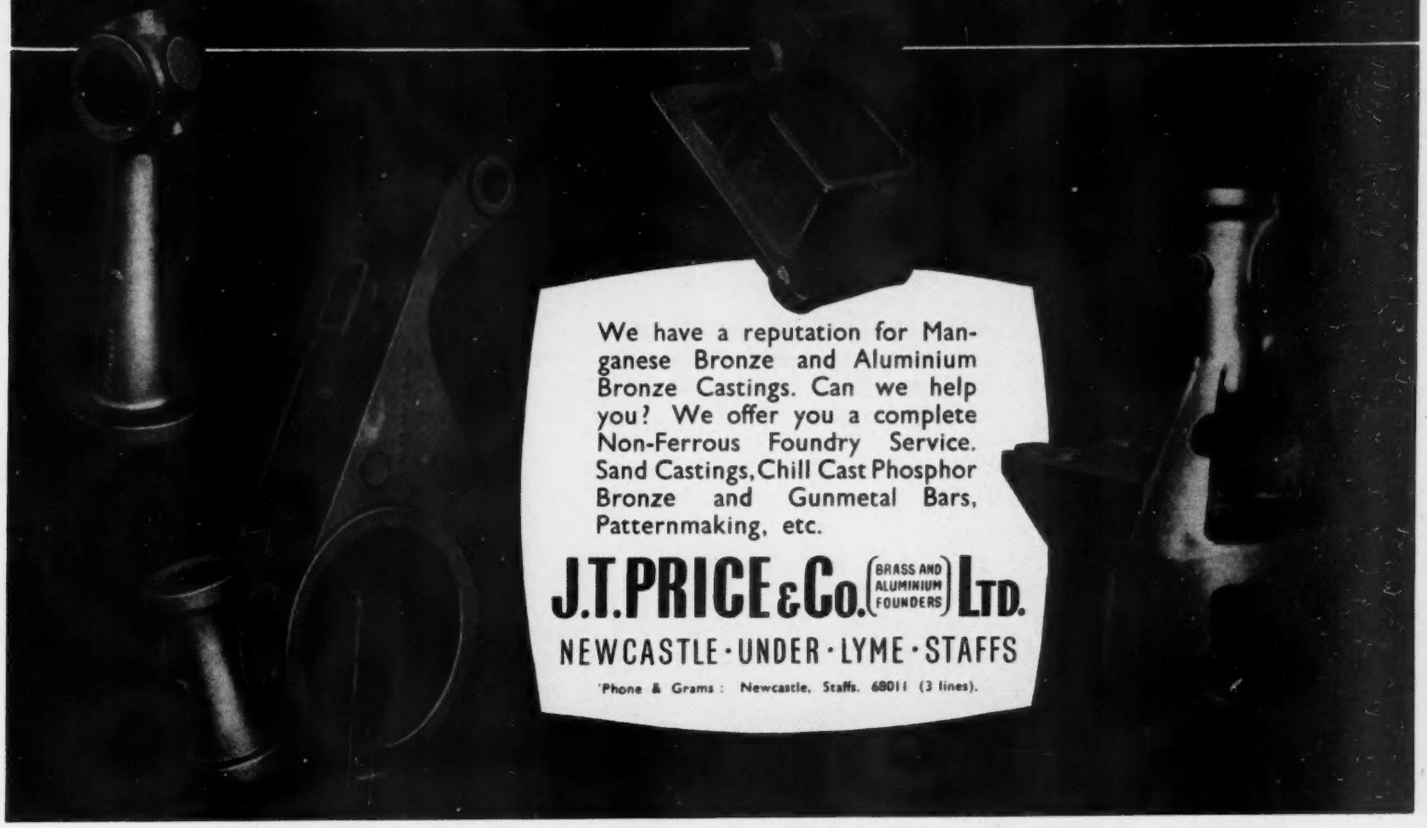
Goodyear **the small pump with a big heart**

GOODYEAR PUMPS LIMITED, Camborne, Cornwall. Telephone: Camborne 2275

One of the companies of the world-wide Holman Organisation, which has agents, branches and technical representatives throughout the U.K. and in 84 other countries.

GY2

MANGANESE BRONZE CASTINGS



We have a reputation for Manganese Bronze and Aluminium Bronze Castings. Can we help you? We offer you a complete Non-Ferrous Foundry Service. Sand Castings, Chill Cast Phosphor Bronze and Gunmetal Bars, Patternmaking, etc.

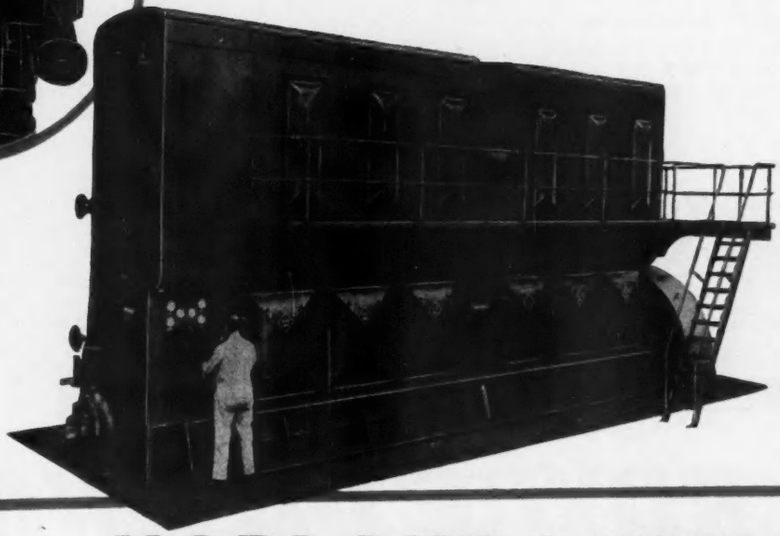
J.T.PRICE & Co. (BRASS AND ALUMINIUM FOUNDERS) **LTD.**

NEWCASTLE · UNDER · LYME · STAFFS

'Phone & Grams: Newcastle, Staffs. 68011 (3 lines).

H&W *Oil Engines*

2-STROKE
OPPOSED-PISTON
ECCENTRIC TYPE



AVAILABLE IN POWERS UP TO 6,000 B.H.P.

turbo-charged with air-cooling, resulting in greater output and reduced fuel consumption

One of eleven 6-cyl. engines ordered by the Iraq Petroleum Company.

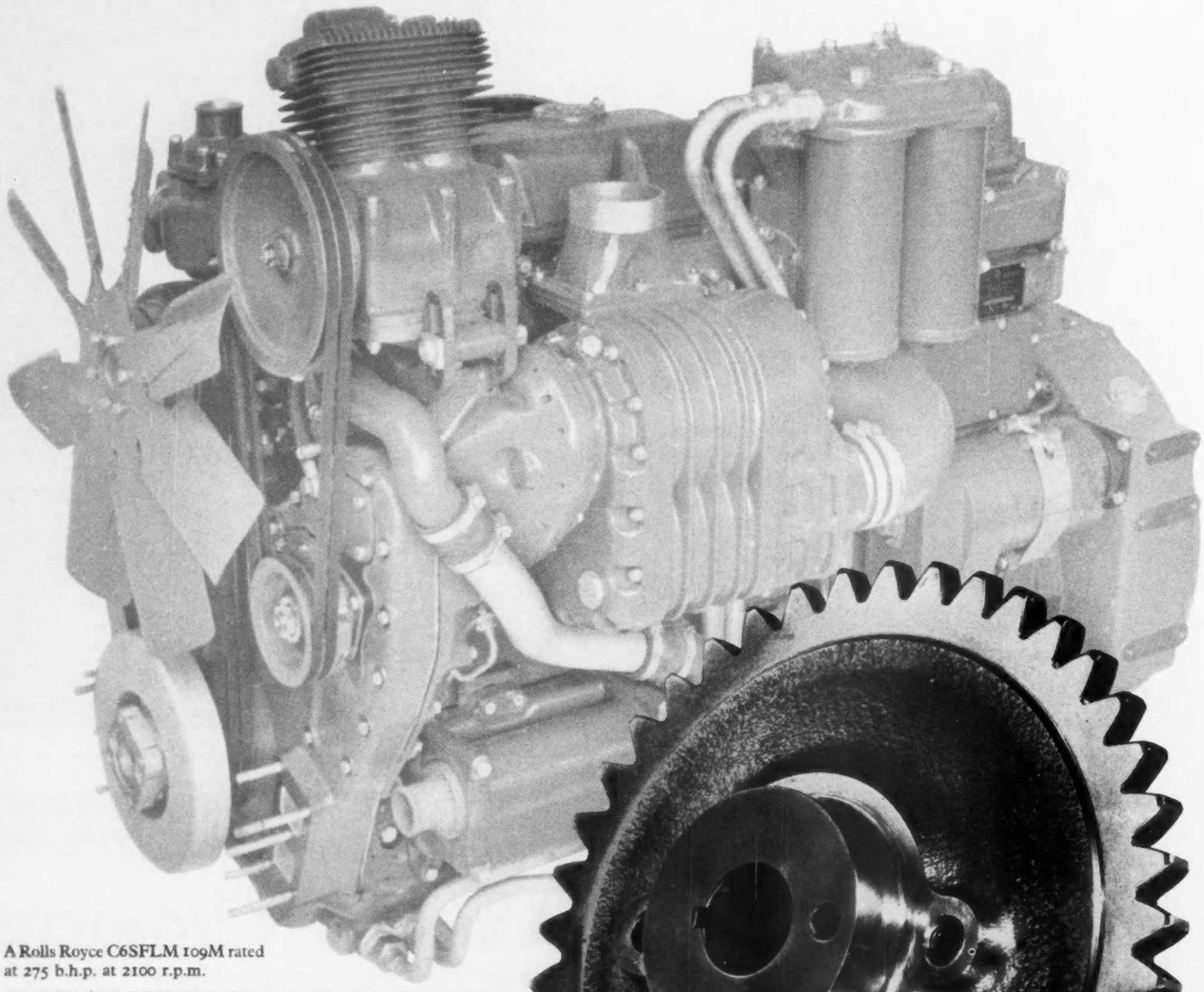
we also supply
Four-stroke engines with or without pressure induction as oil or dual-fuel engines up to 2,100 b.h.p.

HARLAND & WOLFF
LIMITED

Enquiries: Queen's Island, Belfast
London Office: 9, Whitehall, S.W.1

BELFAST GLASGOW LONDON LIVERPOOL SOUTHAMPTON

PRECISION...



A Rolls Royce C6SFLM 109M rated at 275 b.h.p. at 2100 r.p.m.

Oil Pump Drive Gear for the above engine manufactured by Angus to Rolls Royce specifications.

Angus

Gears SELECTED FOR

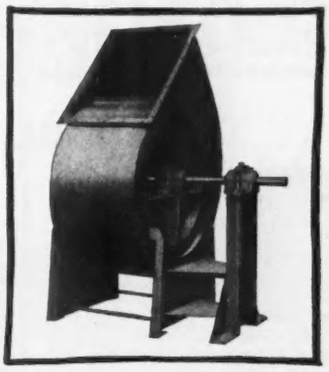
G.A. 91

ROLLS ROYCE OIL ENGINES

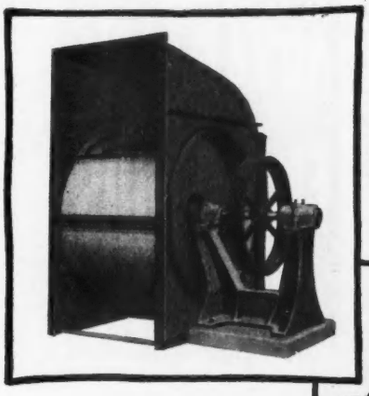
'GAMESH' GEORGE ANGUS & CO. LTD., GEAR DIVISION, PRINCE CONSORT ROAD, HEBBURN-ON-TYNE

CYCLONE

FANS AND EQUIPMENT

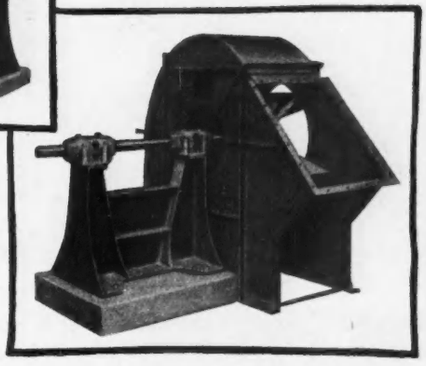


SLOW SPEED MULTIVANE FAN (Intermediate size).



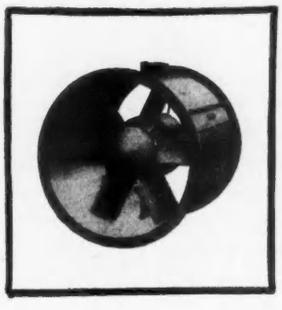
SLOW SPEED MULTIVANE FAN (Large size).

Air ways

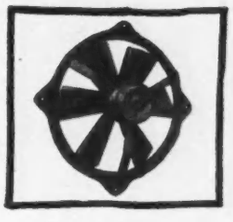


PADDLE BLADE FAN.

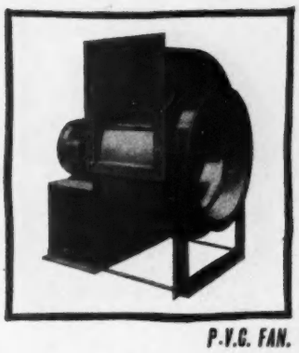
are our ways



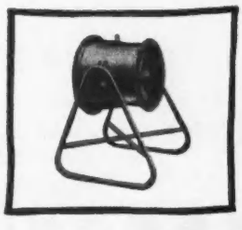
AXIAL FLOW FAN.



PROPELLER FAN.



P.V.C. FAN.



MAN COOLER FAN.

Ventilation, dust collection, fume removal and cooling industrial "hot spots" are jobs for Cyclone Fans and Allied Equipment. 75 years' experience, technical advice and comprehensive literature is yours on request.

MATTHEWS & YATES LTD.

CYCLONE WORKS · SWINTON (MANCHESTER)
TELEPHONE: SWINTON 2273 (4 lines)

& 135 RYE LANE, PECKHAM, LONDON S.E.15
TELEPHONE: NEW CROSS 6571 (4 lines)

Also at: Glasgow · Leeds · Birmingham · Cardiff · Bournemouth

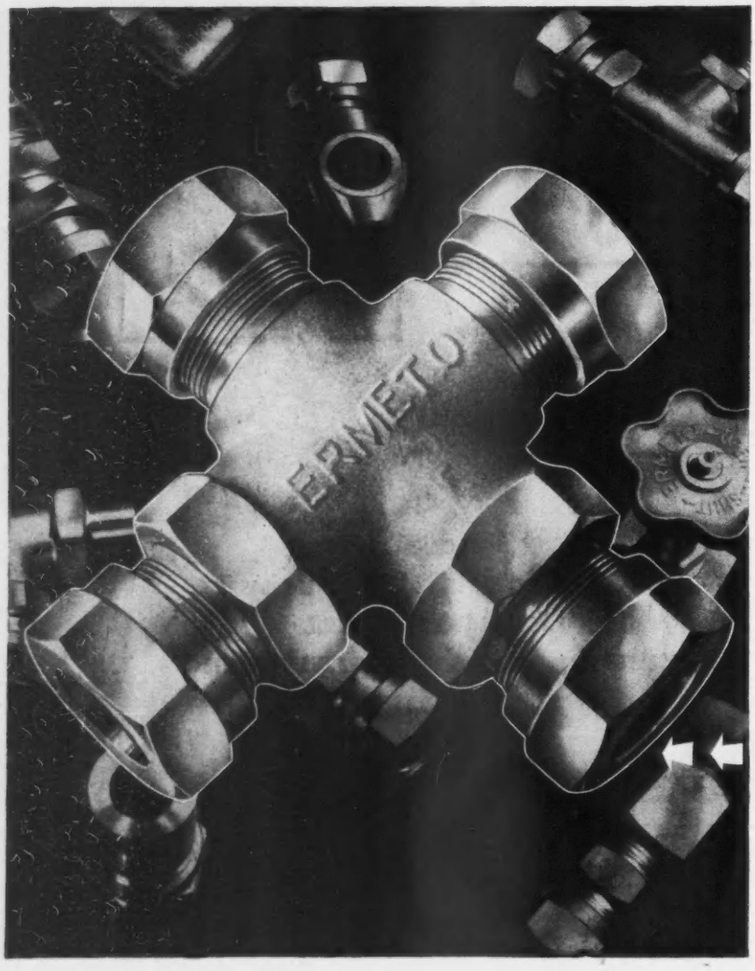
9026

FLUID-DRIVEN SHEARING MACHINES

GUARANTEED TO SHEAR TO WITHIN ·005 IN. ACCURACY

THE ADVANTAGES ARE ENORMOUS *Investigate!*

J. RHODES & SONS LTD.
WAKEFIELD, ENG.



Internationally Recognised

ERMETO fittings are the internationally recognised means of coupling high pressure pipe lines. Enormous numbers are in use throughout the world. The joints are manufactured in seven different countries: the United States of America, France, Germany, Sweden, Holland, Spain, and — last but not least — Great Britain.
In this country the British Ermeto Corporation manufactures a range of fittings unequalled by any other country. And the parts are regularly supplied in mild steel, stainless steel, brass, bronze and aluminium for all pipe sizes, standard and non-standard, up to 2" o.d.

A wide range of valves is also available.
Catalogues on request.

ERMETO

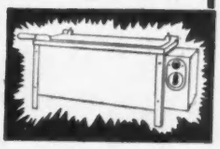
BRITISH ERMETO CORPORATION LTD
Beacon Works, Hargrave Road, Maidenhead
Telephone: Maidenhead 2271-4

PROTECTION

against **ROUGH HANDLING**

"GLOSCOAT" is a plastic protective packaging material for the protection of tools, machine parts and simple assemblies. It is applied by dipping and removed by stripping. It protects against corrosion, rust and rough handling and can reduce packaging time by at least 60 per cent man-hours.

Type L. Tank.



GLOSCOAT

Manufactured by Glostics Ltd., Gloucester, England.

***STRIPPABLE HOT DIP* PROTECTIVE COATING**

SOLE DISTRIBUTORS FOR THE U.K.

Write Dept. BC/2 for full technical details.

J. M. STEEL & CO. LTD.

36/38 Kingsway, London, W.C.2. Tel.: Hol. 2532/5

Branch Offices:

51, South King St., Manchester 2 Tel.: Deansgate 6077/9

45, Newhall St., Birmingham 3. Tel.: Central 6342/3

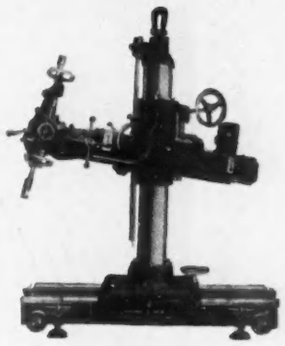
MORE THAN A PRICE LIST —THESE NEW UNBRAKO PUBLICATIONS ARE AN INVALUABLE SAFEGUARD OF YOUR INTERESTS

Every buyer, every user of screws should have these latest Unbrako lists. Forming a detailed and comprehensive guide to the whole Unbrako range, standard and non-standard, they will prove an invaluable addition to your bookshelves and enable you to always specify Unbrako screws for any job rather than risk screws that may lead to costly breakdowns.

A postcard or telephone call will bring your copies by return.

UNBRAKO SOCKET SCREW CO UNBRAKO LTD · COVENTRY

K&W FOR DRILLING, BORING, TAPPING AND HONING MACHINES



U.3

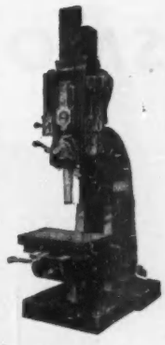
Portable Universal Radials
4ft. to 7ft. radius

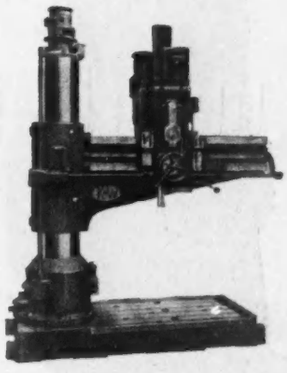
Girder Radials
4ft. to 12ft. 6ins. radius

VII Vertical Machines

Compound or Plain Tables

32" and 40" sizes





E.27

36 Speed Radials
6ft., 7ft. and 8ft. radius

KITCHEN & WADE LTD.

HALIFAX, ENGLAND

Phone: Halifax 61173

WHERE QUALITY IS IMPORTANT...

LANGLEY

Corrosion Resistant

NICKEL ALLOYS

are unsurpassed

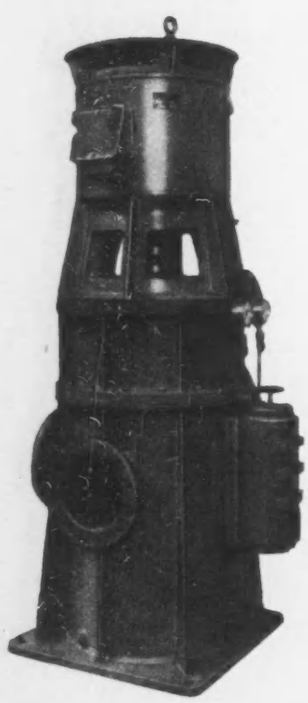
Please ask for full details of the Langley range of Nickel Alloys for duties where reliability in service is essential

LANGLEY ALLOYS LIMITED · LANGLEY · SLOUGH · BUCKS

TELEPHONE: LANgley 432 (7 lines)

LANGLEY Special ALLOYS

SMOOTH – STEADY – SILENT



Oil Pumping

Mirrlees IMO Pumps are widely used for main engine forced lubrication and piston cooling aboard ship. In fuel oil burner supply IMO Pumps assist atomisation by producing a steady flow without pulsation.

Positive Displacement · High Speed · Silent Operation · High Suction Lift when necessary · Self Priming.

- FUEL OIL TRANSFER
- FUEL OIL BURNER SUPPLY
- LUBRICATING OIL SUPPLY

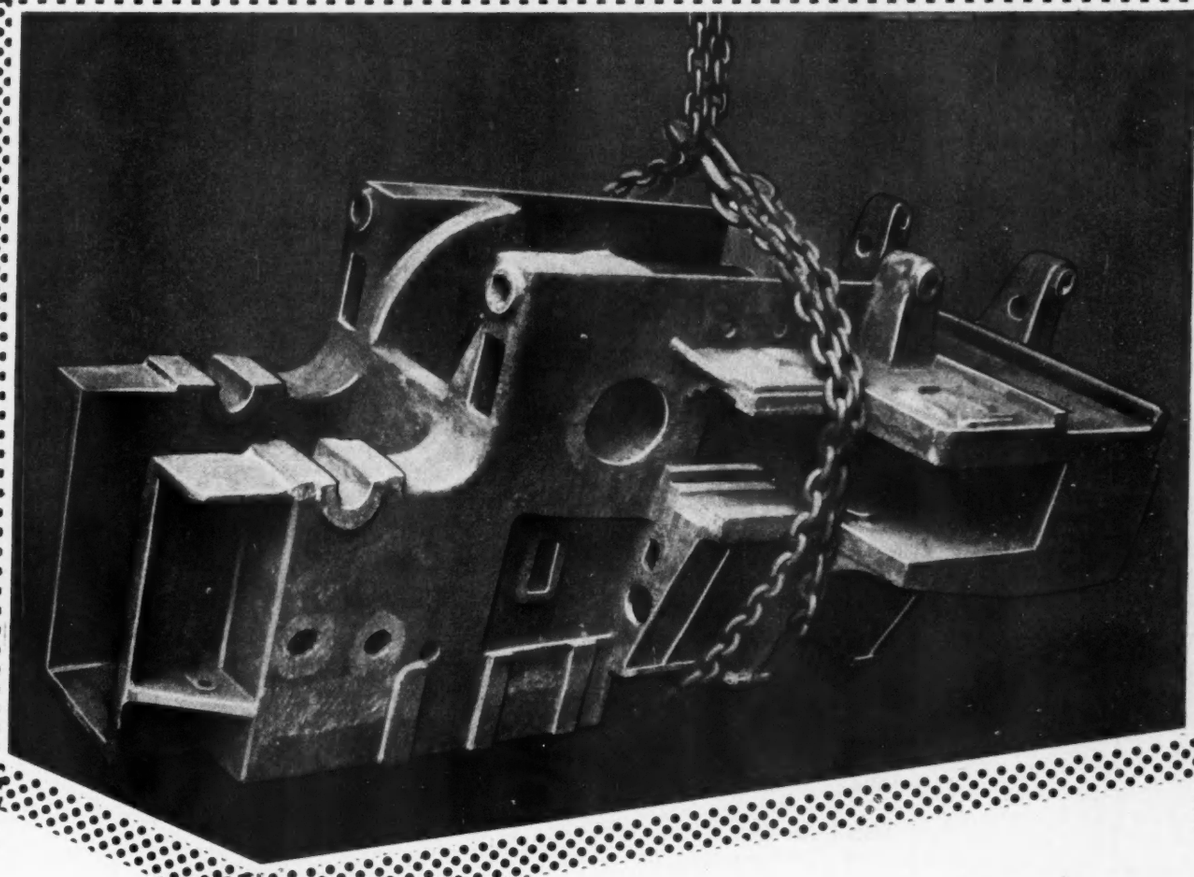
MIRRLEES (ENGINEERS) LTD.

Subsidiary of the Mirrlees Watson Company Limited

EARL HAIG ROAD, HILLINGTON, GLASGOW, S.W.2.

London Office: 38, Grosvenor Gardens, S.W.1 Phone: SLOane 6221-2.

MIRRLEES IMO PUMPS



THIS CASTING WILL MAKE FORGINGS

The casting shown here was produced in the Edgar Allen Steel Foundry for John Stirk and Sons, as the frame for a horizontal forging and upsetting machine. Although intricate in shape, the casting will be subject to extremely heavy stresses and shock loads, and special consideration was given in the design, pattern-making and selection of steel to meet these conditions.

The Edgar Allen Steel Foundry produces castings of any size, shape, and weight from a few ounces to 14 tons, and will just as readily tackle orders for repetition quantities as for the single casting shown above.

Let us tell you more about the service our Steel Foundry can offer, and show how it can help you with your castings problems. Fill in the request form below, and we will send you our " Steel Foundry Book".

Edgar Allen & Co. Limited

IMPERIAL STEEL WORKS · SHEFFIELD · 9

For this Booklet post the coupon to-day

To EDGAR ALLEN & CO. LTD. Er/SC13
SHEFFIELD 9

Please send your Steel Foundry Book to:—

Name .....

Position .....

Firm .....

Address .....

R. H. Campbell
SALES DIRECTOR
STOCKPORT

Bob Holland
BIRMINGHAM

Bill Budd
MONTREAL

Worldwide

You may know some of the men who sell WHARTON cranes. But you won't know the men who actually build them. And that's a pity.

We know them. We know the excellence of their work, the skill and experience which they use to such good—and lasting—effect.

Eric Ward, for instance. He began learning about WHARTON cranes when he joined our machine shop 39 years ago, to be followed 25 years later by his son Donald.

"It's the sort of place," says Eric, "where you can put your heart into the job and know that people appreciate your work. And there's always plenty of it. I've been on overtime since 1927."

It's natural that the Wards and others like them are busy. Because people DO appreciate cranes built by such craftsmen . . . WHARTON cranes.

THE WHARTON CRANE & HOIST CO. LTD.

REDDISH STOCKPORT ENGLAND

Phone: Heaton Moor 2227. Grams: "Gallant, Manchester." Code: Western Union

LONDON : Lincoln House, 296/302 High Holborn W.C. 1	Phone : Chancery 7911.	Grams : Chancery 7911.
SCOTLAND : Fisher-Baxter & Co., 140 West George Street, Glasgow C. 2.	Phone : Douglas 1061-2-3.	Grams : Fluorspar, Glasgow.
MIDLANDS : A. R. Holland & Son, 89 Cornwall Street, Birmingham 3.	Phone : Central 1457.	Grams : Central 1457, Birmingham.
SOUTH-WEST : R. C. Collins, 48 Westbourne Road, Penarth, Glamorgan.	Phone : Penarth 1527.	Grams : Penarth 1527.
NORTHERN COUNTIES : Fisher-Baxter & Co., 140 West George Street, Glasgow C. 2.	Phone : Douglas 1061-2-3.	Grams : Fluorspar, Glasgow.
NORTHERN IRELAND : General Engineering Products Ltd., 7/9 Great Patrick Street, Belfast.	Phone : Belfast 23743.	Grams : Belfast 23743.
EIRE or SOUTHERN IRELAND : Charles Nolan & Co., 2 Parker Hill, Lower Rathmines Road, Dublin.	Phone : Dublin 93510.	Grams : Dublin 93510.
CANADA : Marshall Equipment Co. Inc., P.O. Box 28, 61 Victoria Avenue, Dorval Station, P.Q.	Phone : Melrose 1-3528.	Grams : Marquipco, Montreal.

REPRESENTED IN PRINCIPAL COUNTRIES THROUGHOUT THE WORLD.

794-2

PUMPING SETS

FOR ALL DUTIES

Mather & Platt specialise in the production of motor-driven pumping sets. The illustration shows Mather & Platt motor-driven pumps in a water-supply pumping station. Working from 415v. two sets each deliver 833 g.p.m. against a 300 ft. head (120 b.h.p., 970 r.p.m.) and the other two each deliver 500 g.p.m. against 300 ft. (68 b.h.p., 965 r.p.m.). The induction motors are of the double squirrel-cage type with drip-proof enclosure.

Mather & Platt
LIMITED

PARK WORKS - MANCHESTER 10

Telephone: COLlyhurst 2321
Telegrams: Mather, Manchester.

THE MASTER CLEANER

The greatest enemy of efficient production—DUST, whether it is creating a fire risk, damaging machinery, blanketing heat and light, jeopardising health, ruining paint or causing extra labour can, unknown to you, gradually whittle down your profits. You cannot SEE the NEED—but it is there all the same, and can be eradicated by NEW WELBECK industrial suction cleaners—the most advanced and efficient machine on the market today. Your premises need NEW WELBECK to restore lost profits.

Write now for further information to DEPT. 34.

WE SERVE THE LEADERS OF INDUSTRY.

BRITISH THOMSON HOUSTON use NEW WELBECK industrial suction cleaners. The 'SIMPLEX' model cleaner in use at the B.T.H. Works, Rugby.

By appointment to H.M. The Queen Suppliers of Vacuum Cleaners

NEW WELBECK LTD.

HEAD OFFICE & WORKS:
Moulsecoomb Way, Brighton, 7, Sussex
Tel.: Brighton 61666 (PBX)

LONDON OFFICE:
6 Cavendish Square, London, W.1
Tel.: LANgham 1517 (PBX)

BRANCHES AT BIRMINGHAM, MANCHESTER, SCOTLAND & EIRE

N25

"Vokes 'Top Servicing' lubricating oil filter makes life a lot easier!"

'Top Servicing' is yet another Vokes development. It cuts maintenance time to a minimum — saves man hours and money. You simply unscrew the clamp ring, remove the cover plate and inner seal, and withdraw the filter element. The clamp ring may be locked in any radial position, a particularly useful feature in confined spaces. 'Top Servicing' is typical of Vokes practical approach to filter problems. If you have a filtration problem please contact our engineers. They will be glad to help you.

VOKES *Pioneers of Scientific filtration*

VOKES LIMITED · GUILDFORD · SURREY

Telephone: Guildford 62861 (6 lines) · Telegrams and Cables: VOKESACESS, GUILDFORD, TELEX · Telex: 13-535 VOKESACESS GFD.

Vokes (Canada) Ltd., Toronto. Vokes Australia Pty. Ltd., Sydney. Represented Throughout the World

V277

POLLARD

SOLID & FLEXIBLE ROLLER BEARINGS

Full range of Solid and Flexible Roller Bearings available from 10 mm. to 350 mm. shaft diameter. Ask for catalogue RFX. High capacity Max-Load Roller Bearings in a very wide range also available. Ask for catalogue MAX.

All interchangeable with and equivalent to bearings of American type and manufacture.

POLLARD BEARINGS LIMITED

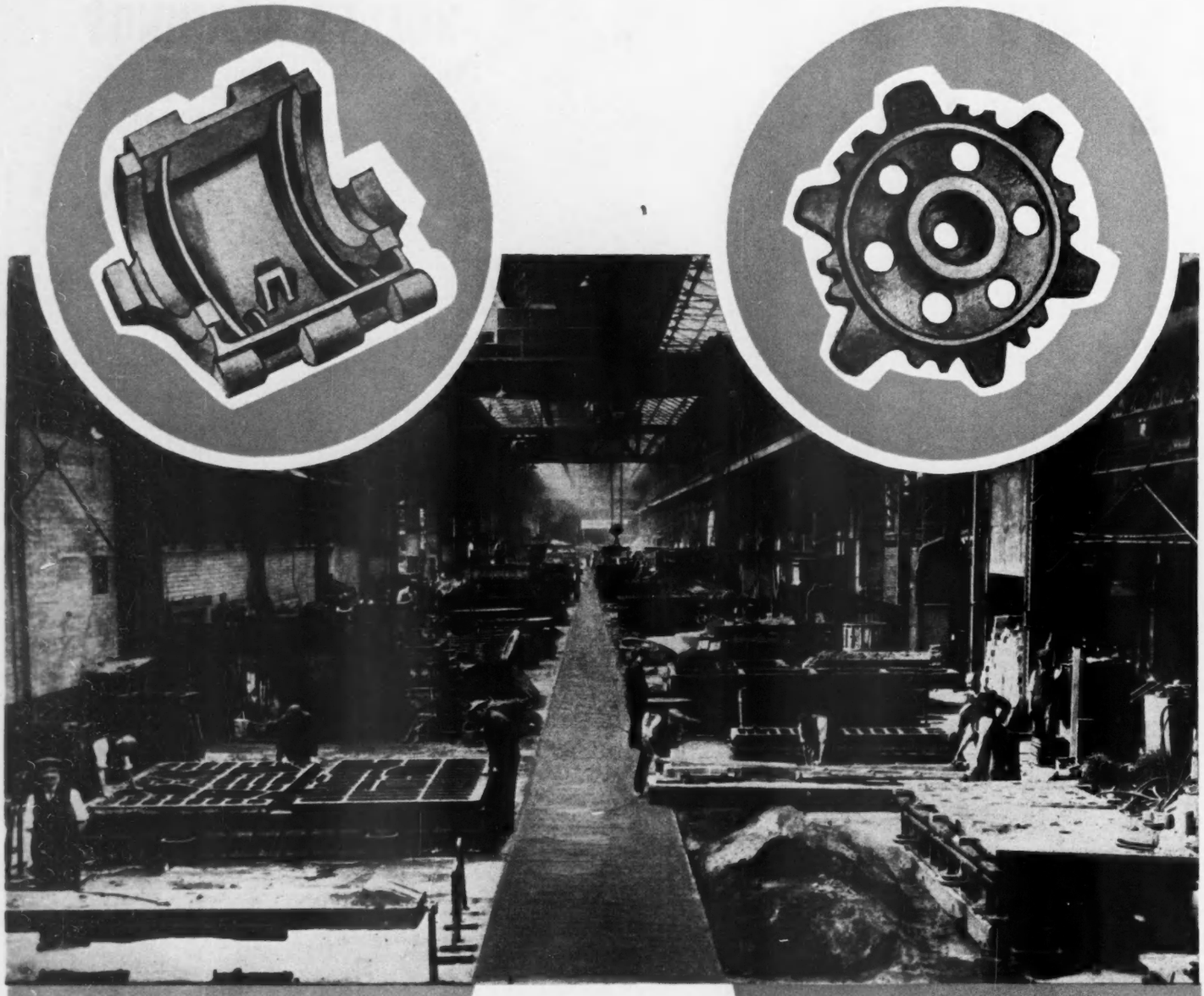
FERRYBRIDGE, KNOTTINGLEY, YORKS. Tel: Knottingley 2323 Telex: 55-166

London Office: 44 Hertford Street, London, W.1. Tel: Legation 3888 Telex: 23549

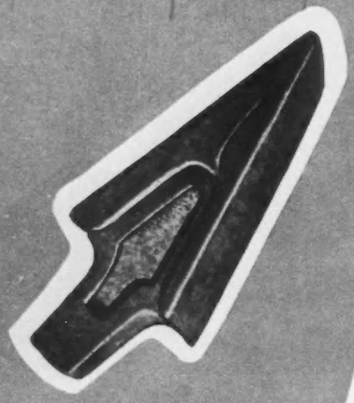
POLLARD BEARINGS (NORTHAMPTON) LTD., COUNTESS ROAD, NORTHAMPTON. Tel: 3766 Telex 31-624

CANADIAN POLLARD BEARINGS LTD., BOX 424. OAKVILLE, ONTARIO. Tel: VI.5-166

REPETITION STEEL CASTINGS



IN CARBON, LOW ALLOY, MANGANESE AND OTHER WEAR RESISTING STEELS, STAINLESS AND HEAT RESISTING STEELS.



HADFIELDS SHEFFIELD

HADFIELDS LTD., EAST HECLA WORKS, SHEFFIELD, ENGLAND.

On-the-Spot Service FOR all CUSTOMERS

ALL TYPES OF PLANT EQUIPMENT

By Appointment to H.M. The Queen
Agricultural Engineers

P.W. Dilloway LIMITED

RECONDITIONING OF

WE COLLECT AND DELIVER

P. W. DILLOWAY LIMITED

HEAD OFFICE AND WORKS: **SOUTHALL, MIDDLESEX** Telephone: SOUTHALL 6511

SCOTTISH OFFICE AND WORKS: **32 BURNFIELD ROAD, GIFFNOCK, GLASGOW** Telephone: GIFFNOCK 1125-6

WEST COUNTRY OFFICE AND WORKS: **TEIGNMOUTH, DEVON** Telephone: TEIGNMOUTH 1325

Trouble-free pumping is as simple as this

Combining the characteristics of the triple-ram pump with the compactness and simplicity of the centrifugal type, Megator pumps have set a new standard of performance. The rotor and the three rubber-lined plastic 'shoes'—the only moving parts—are self-compensating for wear and can be inspected by removing one cover. Self-priming, with high suction lift and constant capacity at varying heads, Megator pumps will handle many troublesome jobs. If you suffer from pump trouble, get in touch with Megator.

MEGATOR

SOME MEGATOR FACTS

High suction lift *permits installation in convenient positions.*

Self-priming *inherent without any added device.*

" ***Snoring*** *" ability sucks out the last drop.*

Constant capacity *at varying pressures.*

Sustained performance. *Self-compensating for wear.*

Simple. *Designed for easy maintenance.*

Capacities. *From 4 to 250 gall. per minute.*

MEGATOR PUMPS & COMPRESSORS LTD · 43 BERKELEY SQUARE · W1 · Telephone: GROsvenor 6946

TGA M101

Boiler Feeding

in the new

Nuclear Power Stations

2 of the four stations now being built in the United Kingdom

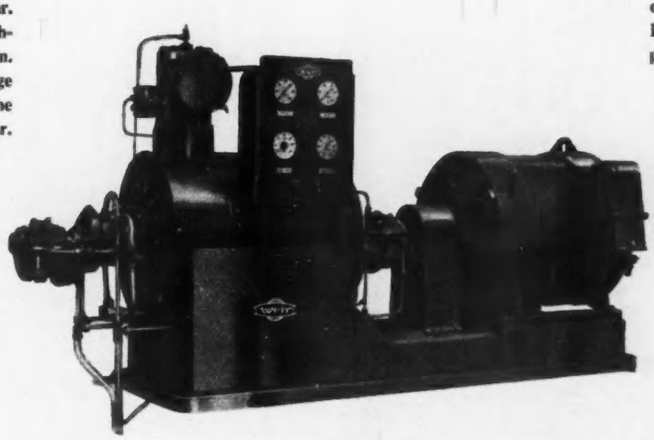
will be completely equipped with

Weir ELECTROFEEDERS

This is only a part of the major feed pump work in hand for the electricity supply industry in this country and overseas, for nuclear and conventional fuel stations.

HUNTERSTON

Twenty Weir Electrofeeders will be supplied to the order of Simon-Carves Ltd., for the high and low-pressure circuits in the steam raising units at Hunterston. The main high-pressure units will discharge 447,600 lb./hr. at 800 lb./sq. in. and the auxiliary high-pressure units 57,250 lb./hr. at 772 lb./sq. in. The main low-pressure pumps will discharge 658,300 lb./hr. at 323 lb./sq. in. and the auxiliary low-pressure pumps 85,000 lb./hr. at 264 lb./sq. in.

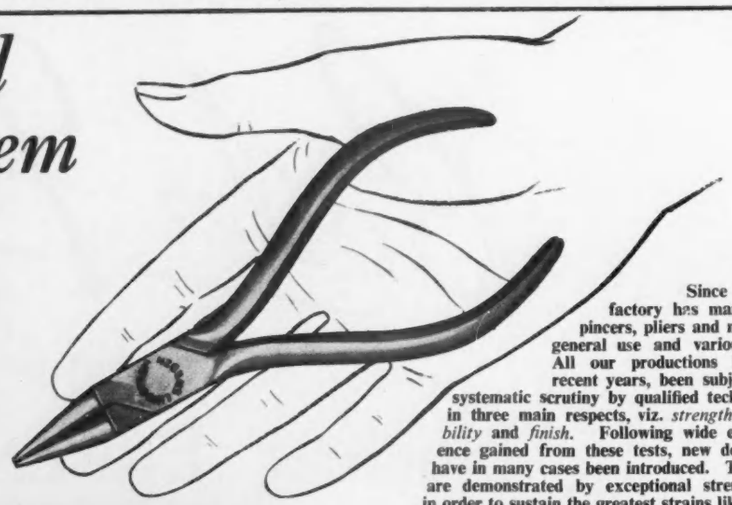


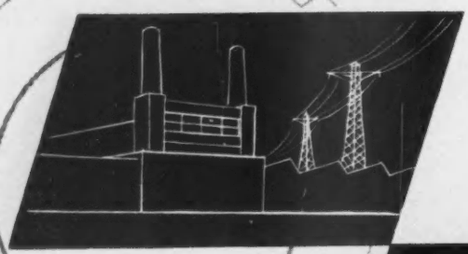
BERKELEY

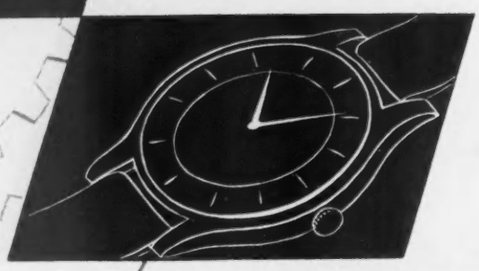
Six Weir Electrofeeders, each with an output of 1,000,000 lb./hr. at 500 lb./sq. in. and two Weir Electrofeeders each having an output of 66,000 lb./hr. at 410 lb./sq. in. have been ordered by John Thompson (Water Tube Boilers) Ltd., for the Berkeley nuclear power station.

G. & J. WEIR LTD., CATHCART, GLASGOW, S.4

You've got to hand it to them





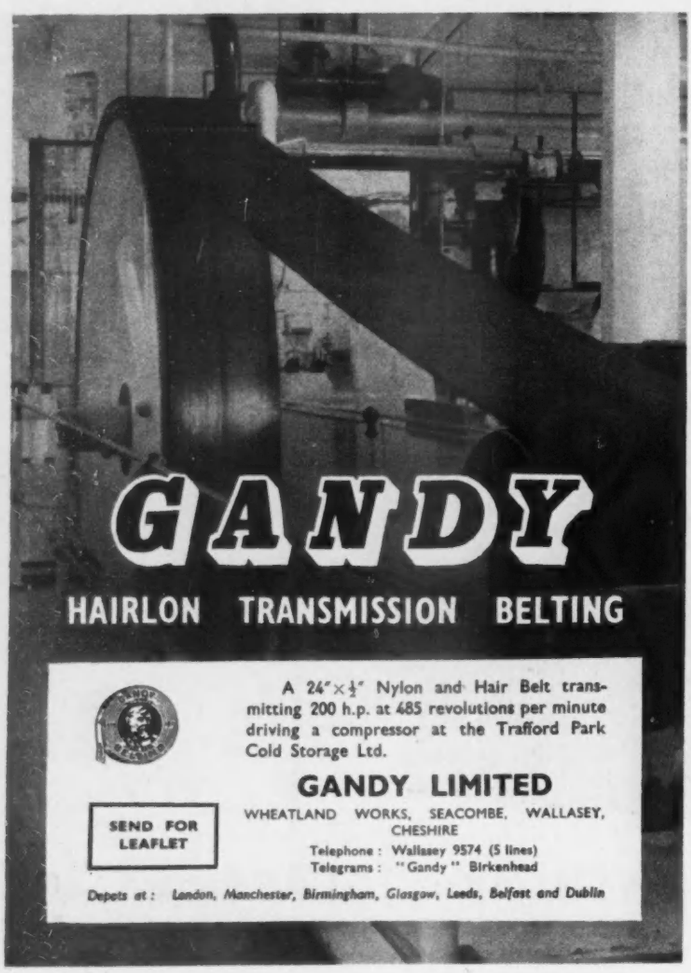


Since 1856 our factory has manufactured pincers, pliers and nippers for general use and various trades. All our productions have, in recent years, been subjected to systematic scrutiny by qualified technicians in three main respects, viz. *strength, flexibility* and *finish*. Following wide experience gained from these tests, new designs have in many cases been introduced. These are demonstrated by exceptional strength in order to sustain the greatest strains likely to occur in the work for which they are intended. The efficiency of a tool is also, to a considerable degree, dependent on the finish, especially of the surface in contact with the hand manipulating the tool. The *Lindström* finish is the result of surface treatment by special methods which give the hand a comfortable grip. In this way we have endeavoured to meet the most exacting demands of users and still further strengthen the confidence already enjoyed by our productions. Hence *you've got to hand it to them—Lindström make the finest pliers and nippers.*

LINDSTRÖM

Obtainable from all Ironmongers, Hardware Stores and usual suppliers or write for details mentioning 'THE ENGINEER'

WM. A. MEYER LTD, 9–11, GLENELDON ROAD, LONDON, S.W.16.



GANDY

HAIRLON TRANSMISSION BELTING

A 24"×½" Nylon and Hair Belt transmitting 200 h.p. at 485 revolutions per minute driving a compressor at the Trafford Park Cold Storage Ltd.

GANDY LIMITED

WHEATLAND WORKS, SEACOMBE, WALLASEY, CHESHIRE

Telephone: Wallasey 9574 (5 lines)
Telegrams: "Gandy" Birkenhead

SEND FOR LEAFLET

Depots at: London, Manchester, Birmingham, Glasgow, Leeds, Belfast and Dublin

GUNMETAL BODY AND STUFFING BOX.

SCREWED — SQUARE THREAD ON SPINDLE.

RENEWABLE DISC

HYDRAULIC

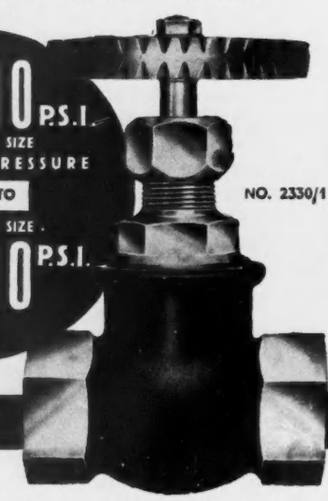
STOP VALVE

FOR HIGH WORKING PRESSURES

LARGER SIZES CAN BE RE-PACKED UNDER PRESSURE

2000 P.S.I. HALF INCH SIZE MAXIMUM PRESSURE DOWN TO TWO INCH SIZE. 1000 P.S.I.

NO. 2330/1



HIGH-TENSILE MANGANESE BRONZE SPINDLE.

OR FLANGED.

ROBERT HARLOW & SON, LTD.

HEATON NORRIS · STOCKPORT · CHESHIRE

Telegrams: "HARLOW, STOCKPORT". Telephone No.: STOckport 3403/4/5

LONDON OFFICE: 10 NORFOLK STREET, LONDON, W.C.2

Telephone: COVent Garden 0315/6/7. Telegrams: "Tubenpipe"—'Phone-London"

3971

"ASTAR"

HEAVY DRIVE

TRADE MARK REGD

CONVEYOR BELT FASTENERS

AVAILABLE IN

STEEL

MONEL METAL

and TUNGUM

J. B. STONE & CO. LTD.

ENGINEERS & MACHINE TOOL MANUFACTURERS

5, BLOOMFIELD PLACE, NEW BOND ST., LONDON, W.1.

Phone: MAYfair 3335/6 Grams: SIGHTSEER, WESDO, LONDON.

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, *e.g.*, ½-page £25 10s. ¼-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, *e.g.*, ½-page £22. ¼-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/-, which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*— Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

KUMASI COLLEGE OF TECHNOLOGY

LECTURERS

Applications are invited for the following posts in the Department of Electrical Engineering :—
(1) SENIOR LECTURER IN TELECOMMUNICATIONS ; (2) SENIOR LECTURER IN ELECTRIC POWER MACHINES ; (3) LECTURER IN ELECTRICAL ENGINEERING.

The College prepares students for the London University B.Sc. Degree in Engineering and for the examinations of the professional Engineering Institutions.

Qualifications : (1), (2)—Good Honours Degree ; A.M.I.E.E. or equivalent professional qualification ; industrial and teaching experience. (3)—A Degree or equivalent professional qualification ; requisite experience to teach Radio and Telecommunications and/or Electronics.

Appointment may be accepted on contract for 5 years or on pension. Arrangements to continue policies initiated under the F.S.S.U. scheme might be made by the College.

Contract Salary Scales: Senior Lecturer : £2125 by £75 to £2425 per annum ; Lecturer : £1281 5s. by £62 10s. to £2031 5s. per annum, plus gratuity payable at end of contract at the rate of £12 10s. for each month of satisfactory service. Pensionable and F.S.S.U. salary scales : Senior Lecturer : £1580 by £60 to £1940 per annum ; Lecturer : £925 by £50 to £1625 per annum. Point of entry according to experience.

Children's allowances up to maximum of three at the rate of £50 per annum per child up to 10 years and £100 per annum per child over 10 years in full time education up to 21 years. Annual leave with free return first-class passages for member of staff and, conditional on minimum stay in West Africa, his wife and up to three children under 17 years. Bungalows with basic furniture at low rental provided. Income tax low.

Applications (6 copies), giving age, education, qualifications, experience, and the names of three referees, should be sent to the Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2. Closing date, 30th March, 1958. E6421

UNIVERSITY COLLEGE OF SWANSEA

LECTURESHIP IN CIVIL OR MECHANICAL ENGINEERING

Applications are invited for a LECTURESHIP IN CIVIL OR MECHANICAL ENGINEERING. Salary on the scale £900–£1650 per annum. Commencing salary can be at any point on the scale according to qualifications and experience. Membership of F.S.S.U. and children's allowance scheme.

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications (six copies) must be sent by Thursday, April 10, 1958. E6395

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF CIVIL ENGINEERING

LECTURER

Applications are invited for the post of LECTURER in the Department of Civil Engineering, at an initial salary within the range £900–£1250 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than 29th March, 1958, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E6377

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)
MILE END ROAD, E.1

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER IN MECHANICAL ENGINEERING. Salary scale £900 by £50 to £1350 (efficiency bar) : £1425 by £75 to £1650 plus London allowance £60 (initial salary according to qualifications and experience), with F.S.S.U. participation and family allowance of £50 for each child. Application forms (obtainable from the Registrar) to be returned by March 25th. E6359

PUBLIC APPOINTMENTS

ROYAL TECHNICAL COLLEGE OF EAST AFRICA

NAIROBI
(Incorporating the Gandhi Memorial Academy)

LECTURERS

Applications are invited for the following posts in the Department of Engineering :—
SENIOR LECTURER IN MECHANICAL ENGINEERING
Qualifications : Hons. Degree in Mechanical Engineering ; A.M.I.Mech.E. ; industrial and teaching experience.
LECTURER IN CIVIL ENGINEERING : LECTURER IN MECHANICAL ENGINEERING
Qualifications : Engineering Degree ; industrial and teaching experience.
ASSISTANT LECTURER IN CIVIL ENGINEERING : ASSISTANT LECTURER IN MECHANICAL ENGINEERING
Qualifications : Engineering Degree, or Corporate Membership of professional Institution ; industrial and teaching experience.

Salary Scales : Senior Lecturer : £1600 by £56 to £1712 by £62 to £2022. Lecturer : £1215 by £41 to £1297 by £48 to £1489 by £55 to £1709. Assistant Lecturer : £979 by £35 to £1084 : £1173 by £41 to £1296.

All posts pensionable. Free medical scheme. Accommodation at low rental or allowance. Passages provided on appointment, termination and on Home leave.

Applications (6 copies), giving age, qualifications, experience and the names of three referees, should be sent to the Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2. Closing date, 27th March, 1958. E6420

UNIVERSITY OF KHARTOUM

(A) SENIOR LECTURESHIP OR (B) LECTURESHIP IN CIVIL ENGINEERING

Applications are invited or (A) SENIOR LECTURESHIP or (B) LECTURESHIP IN CIVIL ENGINEERING.

Salary scales : (A) £S1602 by £S75 to £S1977 per annum ; (B) £S1152 by £S75 to £S1677 per annum, entry point according to qualifications and experience. Cost-of-living allowance approximately £S100 per annum. Outfit allowance £S50. Family allowances : wife—£S60 per annum, 1st child—£S90 per annum, 2nd and 3rd child—£S30 per annum each. (£S1 = £1 0s. 6d. sterling.) Passages for appointee and family on appointment, termination and annual leave. Initial appointment 3 years. Superannuation scheme.

Detailed applications (8 copies), naming three referees, by 15th April, 1958, to Secretary, Inter-University Council for Higher Education Overseas, 29, Woburn Square, London, W.C.1, from whom further particulars may be obtained. E6379

DERBY AND DISTRICT COLLEGE OF TECHNOLOGY

Principal :
T. HEAP, Ph.D., M.Sc., F.R.I.C., A.M.I.I.A.

ASSISTANT IN MECHANICAL ENGINEERING, GRADE A OR B

Applications are invited for the post of ASSISTANT IN MECHANICAL ENGINEERING, GRADE A or B, according to qualifications and experience, to take subjects in the various trades courses within the Department. Duties to commence as soon as possible.

Candidates should have a City and Guilds Final Certificate or equivalent, in one or more subjects, and have considerable industrial experience. Preference will be given to candidates who are qualified to teach welding, steel fabrication and/or workshop technology to Final City and Guilds standard.

Salary in accordance with the Burnham Further Education Report for either Assistants Grade A, £475 by £25 to £900, or Grade B, £650 by £25 to £1025. Both grades have additions for Degree and training and up to 12 increments for approved industrial experience.

Application forms and further particulars can be obtained from the Principal, Derby and District College of Technology, Normanton Road, Derby, by whom completed applications should be received within two weeks of the appearance of this advertisement.

C. MIDDLETON,
E6426 Secretary to the Joint Committee.

PUBLIC APPOINTMENTS

COUNTY OF LEICESTER

COALVILLE MINING AND TECHNICAL COLLEGE

(Principal : W. A. BURROWS, B.Sc.)

HEAD OF DEPARTMENT OF ENGINEERING AND BUILDING, GRADE II

Applications are invited for the new post of HEAD OF DEPARTMENT OF ENGINEERING AND BUILDING, GRADE II (salary £1400 by £50 to £1600).

Applicants should be University Graduates in Engineering and/or have equivalent professional qualifications with appropriate teachingand industrial experience. Further particulars may be obtained from the Principal on receipt of a stamped, addressed envelope.

Applications (no forms), giving age, education, qualifications and teaching and administrative experience, together with copies of two recent testimonials and the names of three referees, should be sent to the Principal, Mining and Technical College, Bridge Road ,Coalville, by 21st March 1958. E6293

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH STATION, GARSTON, HERTS

SCIENTIFIC OFFICER OR SENIOR SCIENTIFIC OFFICER

D.S.I.R. requires SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER at Building Research Station, Garston, Herts, for research on engineering design and construction of nuclear power plants, particularly in concrete and reinforced concrete. Appointment : two years in first instance, with possibility of subsequent transfer to other work on long-term programme. Qualifications : First or Second Class Honours Degree in Civil Engineering, or equivalent. Three years' appropriate post-graduate experience required for S.S.O. Salary ranges : (men), S.S.O., £1130–£1330 ; S.O., £595–£1050. Rather less for women. Five-day week.—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting E.609/7A. Closing date 29th March, 1958. E6366

NATIONAL COAL BOARD

N. W. DIVISION, NO. 1 (MANCHESTER) AREA

PROCESS PLANNER

PROCESS PLANNER required at Central Workshops, Walkden.

Salary in accordance with qualifications and experience.

Good general engineering experience is essential and candidates must have up-to-date knowledge of machine shop practice. Some knowledge of one or more of the following processes is also desirable :—
(a) Steel fabrication.
(b) Blacksmithing.
(c) Electrical machinery repairs.

Applications, stating age, qualifications, experience, present post and salary, to the Area Staff Manager, No. 1 (Manchester) Area, Walkden, Nr. Manchester, within 10 days. E6396

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

INSTRUMENTATION ENGINEER

INSTRUMENTATION ENGINEER required at Atomic Energy Research Establishment, Harwell, for development of new types of instruments, particularly electronic versions, for process control and laboratory measurements.

Applicants should be members of a Senior Engineering Institution or have equivalent qualifications. Salary range £815–£1270.

Send postcard to Group Recruitment Officer (1050Y/25), A.E.R.E., Harwell, Didcot, Berks., for further details and application form. E6381

PUBLIC APPOINTMENTS

STAFFORDSHIRE POTTERIES WATER BOARD

APPOINTMENT OF CIVIL ENGINEERING ASSISTANTS AND DRAUGHTSMEN

Applications are invited for the following appointments :—

(1) THREE CIVIL ENGINEERING ASSISTANTS (Temporary), Grade A.P.T. IV (£1025 to £1175 p.a.). These appointments are not on the permanent staff, but will be for not less than three years. Applicants must be Corporate Members of the Institution of Civil Engineers and have had experience in the design and construction of at least one of the following :—Pumping stations, filtration plant, reinforced and mass concrete service reservoirs and aqueducts.

(2) CIVIL ENGINEERING ASSISTANT, Grade A.P.T. III (£845 to £1025 p.a.). Applicants should be Corporate Members of the Institution of Civil Engineers and preferably have had experience in the design and construction of waterworks.

(3) DRAUGHTSMAN (MECHANICAL), Grade A.P.T. II (£725–£845 p.a.). Applicants should be neat and expeditious draughtsmen with a knowledge of plant layout.

(4) DRAUGHTSMAN (ARCHITECTURAL), Grade A.P.T. I (£575–£725 p.a.). Applicants should be neat and expeditious draughtsmen and had experience in architectural work.

For appointments (1) and (2) the Board will provide housing accommodation for the successful candidates if required.

Reasonable removal expenses will be allowed by the Board.

The appointments are subject to the provisions of the National Scheme of Conditions of Service ; to the provisions of the Local Government Superannuation Act, 1937 ; to termination by one month's notice on either side, and to the successful candidates passing a medical examination.

The Board have considerable major works in hand which are to be completed within the next three to five years. These works include the development of an impounding reservoir scheme with the design and construction of pumping station, filtration plant, aqueducts up to 40in diameter and concrete service reservoirs up to 10 million gallons capacity.

Applications stating age, full details of training, qualifications, present and previous appointments, details of experience, together with copies of two recent testimonials, or the names of two persons to whom reference can be made, and clearly stating for which post they are applying, should be forwarded to the undersigned not later than the 17th March, 1958.

C. V. BROWN, M.I.C.E., M.I.Mech.E., M.I.W.E.,
Engineer and Manager and Clerk.
Albion Street,
Hanley,
Stoke-on-Trent. E6343

CIVIL SERVICE COMMISSION

SENIOR SCIENTIFIC OFFICERS (a) SCIENTIFIC OFFICERS (b)

Pensionable posts for men and women in major scientific fields, including meteorology. A few vacancies for biologists, including specialised posts in marine zoology (sponges), taxonomic entomology, fungus systematics. Qualifications : normally First or Second Class Honours Degree in Science, Mathematics or Engineering, or equivalent attainment ; additionally, for (a) at least 3 years' relevant (e.g. post-graduate) experience. Normal age limits : (a) between 26 and 31, (b) between 21 and 28. London salaries (men) : (a) £1190–£1410, (b) £635–£1110. Five-day week generally.—Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting (a) S.53/58, (b) S.52/58. E6365

FEDERATION OF MALAYA

MECHANICAL ENGINEER

Interesting position in Federation of Malaya with excellent prospects and generous terms, is offered to MECHANICAL ENGINEER with good personality. Minimum qualifications are B.O.T. First-Class Steam and Diesel Certificates and suitable experience of plant and electrical maintenance. Applicants up to age 30 years will be considered. Initial emoluments not less than £2000 per annum. Duties will involve supervision of factories producing concentrated rubber latex.

Apply, with full particulars, to BOX No. 1539, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4. E6391

PUBLIC APPOINTMENTS

KAMPALA MUNICIPAL COUNCIL

APPOINTMENT OF WORKS SUPERVISOR (ELECTRICAL)

Applications are invited for the above post in Council's Sewage Disposal Works in Council's Salary Scale IV : £879 by £33 to £945 by £36 to £1017 by £39 to £1173 by £42 to £1341 (including inducement pay). The commencing salary within this scale will depend upon the qualifications and experience of the successful applicant.

Applicants must be capable of maintaining electrically-driven machinery consisting of Rag Pickers, Conveyors, Scrapers, and Water and Sludge Pumps of up to 1100 g.p.m. each. Preference will be given to applicants with suitable experience in the maintenance of electrical equipment comprising of motors from one to fifty H.P. with relevant switch gear and controls, &c. Experience in a modern sewage purification works or water works will be an additional advantage.

The appointment is to Council's permanent staff under Part I of Council's Regulations and Terms of Service, which includes home leave after thirty to thirty-six months and up to four adult passages for expatriate officers and their families. Free medical and dental benefits are provided and housing, complete with heavy furniture, at a low rental.

The successful applicant, if less than 50 years of age, will be required to contribute to Council's superannuation scheme at the rate of 7½ per cent. of salary. If over 50 years of age, a Provident Fund Scheme is in operation.

Canvassing of members of the Council directly or indirectly in connection with this appointment will disqualify. The appointment will be subject to a probationary period of at least six months and the selected candidate would be required to submit to a medical examination before appointment.

Applications, giving full particulars, including age, marital status, qualifications, previous experience and the date when the applicant would be free to take up duties, together with the names and addresses of three persons to whom reference can be made, must reach the Town Clerk, P.O. Box 210, Kampala, Uganda, not later than the 29th March, 1958. E6416

SOUTH WEST SUBURBAN WATER COMPANY

ASSISTANT ENGINEER

Applications are invited for the above vacancy in the Chief Engineer's Department.

Candidates should have either an Engineering Degree or have passed Sections I and II of the Institution of Civil Engineer's examination. They should preferably have spent about two years in the water or civil engineering industries.

Duties will be assist in the day-to-day running of the undertaking and with the design and construction of a 3 m.g. reinforced concrete service reservoir. Other new works are contemplated. The company serves an area of approximately 100 square miles, with a population of 200,000.

The salary offered is £800 p.a., or slightly above, according to age and experience. The appointment, which is subject to medical examination, is permanent and pensionable.

Applications, stating age, qualifications and experience, should be sent to the Chief Engineer, South West Suburban Water Company, The Causeway, Staines, Middlesex, as soon as possible.

J. R. BROCK GRIGGS, B.Sc., A.M.I.C.E., M.I.W.E., Chief Engineer.

E6092

MERSEY DOCKS AND HARBOUR BOARD

ENGINEERING ASSISTANTS (THREE)

Applications are invited for the position of ENGINEERING ASSISTANT on the Non-Established Staff of the Board :—

(a) In connection with works to be constructed in the River Mersey for the accommodation of oil tankers.

(b) For work on site of a major docks reconstruction scheme now in progress in Liverpool.

Candidates should be Corporate Members of the Institution of Civil Engineers, although Graduate Members of the Institution would be considered for (b).

Salary for each appointment £700/£900 per annum, according to qualifications and experience. Duration 2/3 years.

Applications, stating age, qualifications and experience, should be addressed to the Engineer-in-Chief, Dock Office, Liverpool, 3. Closing date March 17, 1958.

A. S. MOUNTFIELD, General Manager and Secretary.

Dock Office, Liverpool, 3. E6411

NORTH THAMES GAS BOARD

WESTMINSTER

A SENIOR DRAUGHTSMAN

A SENIOR DRAUGHTSMAN is required in the Chief Engineer's Department at Westminster, for the design of materials handling plant and the detailing of associated steel work.

Candidates should preferably be Corporate Members of the Institution of Civil, Structural or Mechanical Engineers.

Starting salary within the range of £890–£1050 per annum, according to age, qualifications and experience.

The successful candidate will be required to join the staff pension scheme.

Applications, giving age and full particulars, should be sent to the Staff Controller, 30, Kensington Church Street, W.8, quoting reference TE/314. E6339

CENTRAL ELECTRICITY GENERATING BOARD

SOUTHERN, MIDLANDS AND NORTHERN PROJECT GROUPS

PROGRAMMES AND PROGRESS ENGINEERS

Applications are invited from suitably qualified engineers for appointments as PROGRAMMES AND PROGRESS ENGINEER in the Southern, Midlands and Northern Project Groups at offices in London, Birmingham and Manchester respectively.

The selected candidates will be responsible to the Chief Project Engineer for the preparation of detailed programmes and sub-programmes for the progress of all projects administered by the Group, and will be required to work in close collaboration with the Project Engineers. Experience in the planning and construction of modern power stations or other similar major constructional work is essential.

Candidates may indicate a preference for any of the three posts. Provisional salary range £2500 to £2700 p.a., plus £60 London allowance, for the Southern Project Group post.

Applications, stating age, qualifications, experience, present position and salary, should be forwarded to W. J. Rowland, Deputy Chief Personnel Officer, 24–30, Holborn, London, E.C.1. Envelopes should be marked "Confidential," quoting reference ENR/69. E6400

COUNTY BOROUGH OF EAST HAM

ASSISTANT ENGINEER (MECHANICAL)

ASSISTANT ENGINEER (MECHANICAL), Grade II. £725–£845.

London weighting is paid in addition. Salary in excess of the minimum may be paid according to qualifications and experience.

A subsistence allowance may be granted over a reasonable period to the person appointed if unable to obtain suitable housing accommodation, necessitating the maintenance of two homes.

Further details and application forms returnable by 21st March, 1958, from the Town Clerk, Town Hall, E.6. E6353

LONDON COUNTY COUNCIL

ARCHITECT'S DEPARTMENT

CIVIL ENGINEERING ASSISTANTS

Vacancies in the Housing Engineer's Division for CIVIL ENGINEERING ASSISTANTS, with experience in the following classes of work :—

(a) Surveying and levelling and setting out for new roads on large housing estates.

(b) Preparation of drawings for road and sewer work.

(c) Preparation of house drainage plans.

(d) Supervision of civil engineering work.

Applicants for posts (a) and (d) must be prepared to work away from London when required, for which travelling expenses and subsistence allowances in accordance with the Council's scale will be paid. Salary up to £860 a year, according to qualifications and experience.

Application forms, returnable by 20th March, 1958, from the Architect (AR/EK/10/58), The County Hall, S.E.1. (335.) E6352

THE NATIONAL IRANIAN OIL COMPANY

QUALIFIED ENGINEER

The National Iranian Oil Company has a vacancy for a fully qualified ENGINEER, to develop plans and projects for major work such as pipeline, oil refineries, production and distribution installations, loading terminals, &c., and to supervise execution of such plans. Applicants must be Corporate Members of either Institution of Civil Engineers or Institution of Mechanical Engineers or equivalent ; also Fellow of British Petroleum Institute or equivalent. Age limit 55, with 5–10 years in full control of engineering work related to petroleum industry. Salary commensurate with qualifications and experience. Two-year contract with possibility of extension.

Write, giving full details of particulars and experience, to E. Nabavi, 50, Kensington Court, London, W.8. E6322

CENTRAL ELECTRICITY GENERATING BOARD

SENIOR ASSISTANT ENGINEER (BOILER PLANT)

Applications are invited for the appointment of SENIOR ASSISTANT ENGINEER (BOILER PLANT), Chief Engineer's Department, Bankside House, London, S.E.1, to conduct investigations into both the economic and design aspects of large future boiler plant installations for high pressures and temperatures, and their major auxiliary equipment, with particular respect to combustion, stress and chemical engineering considerations. Candidates should preferably be Corporate Members of the Institution of Mechanical Engineers, or the Institution of Chemical Engineers, and have experience in the manufacture or design of boilers or chemical plant. Salary within scale £1435–£1795 p.a.

Application forms obtainable from I. G. Ellis, 24–30, Holborn, E.C.1. These should be returned in envelopes marked "Confidential," quoting reference ENR/62, by 20th March.

S. S. SCOTT, Chief Personnel Officer.

E6358

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

INDUSTRIAL GROUP

ASSISTANT DESIGN ENGINEER

The United Kingdom Atomic Energy Authority, Industrial Group, requires an ASSISTANT DESIGN ENGINEER at Springfields Laboratories, Salwick, Preston, Lancashire, to undertake individual design work of a very high standard and to act as Deputy Leader of a team of draughtsmen.

Recognised engineering apprenticeship and possession of H.N.C., or equivalent, in Mechanical, Chemical or Production Engineering required. Considerable experience in a drawing-office engaged on mechanical and chemical plant design and jig and tool work essential.

Salary assessed within scale £880–£1270.

Contributory pension scheme.

A house or assistance towards legal expenses on house purchase may be available.

Send postcard for application form, quoting reference 2323, to Recruitment Officer U.K.A.E.A., I.G.H.Q., Risley, Warrington, Lancashire.

Closing date : 24th March, 1958. E6403

CENTRAL ELECTRICITY GENERATING BOARD

YORKSHIRE DIVISION

THIRD ASSISTANT ENGINEER

Applications are invited for the position of THIRD ASSISTANT ENGINEER in the Efficiency and Testing Section of the Generation (Operation) Department at Divisional Headquarters, Leeds.

Commencing salary within the range of £1055–£1180 per annum, Grade 5, Class AX, National Joint Board Agreement (Schedule "B"), according to qualifications and experience, rising to an ultimate maximum of £1320 per annum (Class EX).

Applicants should preferably be educated to B.Sc. or equivalent standard, and should have had experience in the operation of modern power stations. Duties will include the testing of power station plant, efficiency investigations at site and probably combustion research on a modern p.f. fired boiler.

The successful applicant will be based at Skelton Grange Power Station, Leeds, but will be expected to travel in connection with his duties.

Application forms obtainable from the Divisional Secretary (Establishments), Central Electricity House, St. Mary's Road, Leeds, 7, to be returned within 14 days of the appearance of this advertisement. E6425

WOOLWICH POLYTECHNIC

Principal : HAROLD HEYWOOD, D.Sc.Eng., Ph.D., A.C.G.I., Wh.Sch., M.I.Mech.E., M.I.Chem.E.

FULL-TIME AND SANDWICH COURSES

DEGREE COURSES

WITH TEACHERS RECOGNISED BY THE UNIVERSITY OF LONDON

Students read for Internal Degrees and are affiliated to the University of London Union and Athletic Union.

B.Sc. ENGINEERING

Civil, Mechanical and Electrical (including Telecommunications).

B.Sc. SPECIAL CHEMISTRY.

B.Sc. SPECIAL MATHEMATICS.

B.Sc. SPECIAL PHYSICS.

B.Sc. GENERAL.

HIGHER DEGREES OF M.Sc. AND Ph.D. in the Faculties of Engineering and Science.

The above are Three-Year Courses. PRELIMINARY COURSES are available for (i) those not possessing G.C.E. Advanced Level (making a Four-Year Course) ; (ii) First Medical Examination, and (iii) Faculties of Economics, Arts and Law.

PROFESSIONAL COURSES

GRADUATESHIP, ROYAL INSTITUTE OF CHEMISTRY.

INDUSTRIAL MANAGEMENT (POST-GRADUATE).

SECRETARIAL AND BUSINESS TRAINING.

SANDWICH COURSES

MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
For the Diploma in Technology.

BUSINESS ADMINISTRATION
For the College Diploma.

Requests for information and applications for admission to be addressed to Woolwich Polytechnic, London, S.E.18. E6328

MIDDLESEX COUNTY COUNCIL

SENIOR ENGINEERING ASSISTANT

SENIOR ENGINEERING ASSISTANT required in County Architect's Department, for the preparation of schemes for the heating of large County Buildings. A.P.T. III, £845–£1025 p.a., plus £30 London Weighting if 26 years or over. 5-day week. Established, subject to medical assessment. Prescribed conditions.

Application forms from County Architect, 1, Queen Anne's Gate Buildings, Dartmouth Street, S.W.1, returnable by April 8th. (Quote X.51E.) Canvassing disqualifies. E6375

CENTRAL ELECTRICITY GENERATING BOARD

ASSISTANT PLANT ENGINEER (Electrical), for site staff at High Marnham Power Station, near Retford, Notts, to supervise the installation and commissioning of electrical equipment and co-ordination of the work with that covered by civil and mechanical plant contracts.

Applicants should preferably hold H.N.C. or equivalent electrical qualifications and have had experience with a manufacturer in a similar capacity at another power station. Whilst the post is designated temporary, it is expected to extend into 1962. Salary within scale £1145–£1270/£1410 (AX/EX.4). Holidays and sick pay schemes.

Applications, giving full details, should be sent to Director of Labour and Welfare, Central Electricity House, 825, Wilmslow Road, Manchester, 20, within ten days of publication. Please quote vacancy No. E.137/70/E. E6335

TENDERS

INDIA STORE DEPARTMENT

TWO-SPINDLE VERTICAL PROFILE MILLING MACHINES

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of: 3 Nos. TWO-SPINDLE VERTICAL PROFILE MILLING MACHINES, table working surface 355×457mm., table top to bottom of cross slide distance between spindles 304mm.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The application for Tender forms should state reference 2098/57/1/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, 28th April, 1958. E6346

DAMODAR VALLEY CORPORATION

COMPLETE ASH HANDLING SYSTEM

The office of the "Damodar Valley Corporation," Anderson House, Alipore, Calcutta, 27, India, invite TENDERS for the following :—

D.V.C. Tender Enquiry No. PE-SPEC 42 for the SUPPLY of a COMPLETE ASH HANDLING SYSTEM for Two Steam Generating Units at D.V.C. Durgapur Thermal Power Station and necessary Additions to the existing Ash Handling Plant at Bokaro Thermal Power Station for the Installation of One Bokaro (fourth) Unit. Maximum coal consumption of two steam generators at Durgapur will be 2400 tons/day and 1200 tons/day for one steam generator at Bokaro. The maximum ash content shall be 45 per cent.

Tenders, specifications, drawings, &c., can only be obtained direct from Damodar Valley Corporation, Anderson House, Alipore, Calcutta 27, India, at a cost of £3 15s. per copy, plus £1 17s. 6d. for Air Parcel charges.

Tenders are to be returned direct to the "Damodar Valley Corporation," of the above address, so as to reach them by 3 p.m. on 1st April, 1958.

Specimen copy of the above specification is on view at "India Store Department," Government Buildings, Bromyard Avenue, Acton, W.3, under reference S.3208/57/AVH/ENG.2. E6376

INDIA STORE DEPARTMENT

TAP GRINDING MACHINE

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of: 1 No. TAP GRINDING MACHINE, similar to "Matrix" No. 55 ; max. dia. of thread ground = 50mm. ; max. length ground at one setting = 100mm. ; max. and minimum pitches = 8 and 60 t.p.i.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings, which is not refundable. Cheques should be made payable to High Commission of India. The application for Tender forms should state reference 2098/57/2/ENG.3.

Tenders, complete with specifications, are to be submitted by Monday, 28th April, 1958. E6345

Classified Advts. continued on page 122

TENDERS

INDIA STORE DEPARTMENT

MAIN BAR FRAMES

The Director General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of:

	Quantity, Nos.
MAIN BAR FRAMES with Frame Clips completely machined on all faces	66 R.H. 66 L.H.

Forms of Tender may be obtained from the above address on or after the 7th March, 1958, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Thursday, 17th April, 1958.

Please quote reference No. 125/57.DB/RLY. E6409

EDUCATIONAL

THE COLLEGE OF AERONAUTICS

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS

Applications are invited for a RESEARCH FELLOWSHIP, which has been established at the College by The English Electric Co., Ltd. The Fellowship is intended to provide opportunity for post-graduate research into the problems of vibration or stability and control of aircraft, and is tenable for one year beginning on or about 1st October, 1958. The value of the Fellowship is £750.

Applications, giving full particulars of education and experience, and quoting the names of three referees, are required by 1st May, 1958, and should be addressed to :

THE WARDEN.
The College of Aeronautics,
Cranfield,
Bletchley,
Bucks. E6354 E

ROYAL CORPS OF NAVAL CONSTRUCTORS

ENTRY FROM PRIVATE SHIPYARDS

A Competitive EXAMINATION for ENTRY into the ROYAL CORPS OF NAVAL CONSTRUCTORS will be held in June, 1958. Accepted candidates will be entered as Probationers in the Royal Corps and will receive a Course of Training mainly at the Royal Naval College, Greenwich. Candidates must not be more than 26 years of age on 1st October, 1958, and must have been engaged in practical shipbuilding for at least eighteen months before entry.

2. Work covers all aspects of design, construction and repair of warships and gives opportunities for service in H.M. Dockyards abroad and in the United Kingdom.

3. Full particulars, including details of substantially improved salaries now payable, may be obtained upon application to the Secretary of the Admiralty (C.E. Branch II), Bath. Intending candidates must send to that address, before the 1st April, full particulars of their education and technical training, and of their practical experience.

PRIVATE STUDENTS OF NAVAL ARCHITECTURE

In conjunction with the above, a qualifying examination will be held for Private Students who desire to take the same Course as that prescribed for Officers of the Royal Corps of Naval Constructors under training. Candidates' applications should reach the Secretary of the Admiralty (C.E. Branch II), Bath, before 1st May. A fee of £50 per session is at present payable by private students taking this Course, but the amount payable is under review. E6392

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E721 E

FREE ! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other professional examinations —E.M.I. Institutes, Dept. E.30, London, W.4. (Associated with H.M.V.). E972 E

ENGINEERS
TRAIN FOR
TECHNICAL TEACHING
Technical teaching offers excellent prospects, good salaries, and security
APPLICATIONS are invited from ENGINEERS for
TRAINING as FULL-TIME TEACHERS IN TECHNICAL COLLEGES
The next course of training will begin in SEPTEMBER, 1958, and end in JUNE, 1959.
Applicants should
(1) Be between about 25 and about 45 years of age.
(2) Have industrial experience.
(3) Possess one of the following :
Higher National Certificate,
Full Technological Certificate of the City and Guilds of London Institute,
Professional qualifications or Degree.
SUBSTANTIAL GRANTS AVAILABLE FREE OF INCOME TAX, WITH FREE TUITION, BOARD AND LODGING.
Write for details and an application form to one of these colleges :
The Director (E/2/14), Bolton Training College, Manchester Road, BOLTON.
The Principal (E/2/14), Garnett College, 83, New Kent Road, LONDON, S.E.1.
The Director (E/2/14), Huddersfield Training College, Queen Street South, HUDDERSFIELD. E6329

EDUCATIONAL

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHT'S LANE, LONDON, W.8. E102 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A MEDIUM-SIZE, BUT EXPANDING JOINERY WORKS in West Country (approx. 70 hands) wishes to appoint a SENIOR ASSISTANT to the Production Manager. Duties comprise production planning for entire works, machine loading, work study and rating (in liaison with estimating section), and the introduction and operation of incentive bonus scheme. Production is of comparatively wide variety involving both long and short runs. The post is a responsible one, offering exceptional scope and prospects for a man possessing the requisite experience and capabilities. A good commencing salary will be paid and a staff pension scheme is in operation. Apply, stating age and full details of experience, also remuneration received.—BOX No. E1669, "The Engineer." A

A TRAINEE ENGINEERS' BUYER is required to assist in the purchase of steels, metal castings and parts of machinery to company's drawings.—Applicants who have passed O.N.C. should write in the first instance, fully describing previous experience and salary envisaged, to The Personnel Manager, Vandervell Products, Ltd., Western Avenue, London, W.3. E6415 A

AN UNUSUAL OPPORTUNITY for a fully qualified and experienced MECHANICAL ENGINEER exists with Quickfit and Quartz, Limited, Stone, Staffordshire. Post for a man with a challenging and inventive frame of mind. To follow up the introduction of developed methods and review continuously existing methods. The organisation, which is concerned with the manufacture of laboratory apparatus and chemical plant in glass, has great scope for someone prepared to apply engineering principles to production operations and capable of making up provisional mechanical aids. Profit-sharing and pension schemes in existence.—Please apply, giving full details of qualifications, experience and salary expected, to Personnel Officer. E1680 A

ALLENS OF BEDFORD
have a vacancy for
AN ASSISTANT TO THE WORKS ENGINEER

The post carries responsibility for the Architectural and Civil Engineering design of new buildings and for modifications to, and maintenance of, existing buildings.

Essential qualifications are a sound technical education and at least 3 years' experience in the design of industrial buildings. Experience in estimating, surveying and site supervision will be useful.

Generous pension scheme. Assistance towards moving expenses.

Apply, stating age and full details of experience to the Personnel Manager, W. H. Allen Sons & Co., Ltd., Queens Engineering Works, Bedford. E6360 A

AMASAL LIMITED, Vacuum Salt Works, Baswich Lane, Stafford, require a WORKS ENGINEER, over 30 years of age, who has sound practical and administrative experience of steam and power generation and general plant maintenance. A qualification in Electrical or Mechanical Engineering would be considered an advantage. Good salary and conditions available to the right man.—Apply, giving full details of experience, to above address, marking letter "Works Engineer." E1684 A

APPLICATIONS INVITED FOR

(a) DESIGNER AND DETAIL DRAUGHTSMEN, for general mechanical engineering, pipework, platework, pressure vessels, heat exchangers, &c.
(b) ELECTRICAL ENGINEERING DRAUGHTSMEN, for complete electrical installation and design work, including motor application, control scheme engineering.
(c) REINFORCED CONCRETE DESIGNER, experienced in the design of foundations and structures for heavy industrial plants.
(d) INSTRUMENT DRAUGHTSMEN, for design, selection, installation, commissioning of modern plants for a rapidly expanding instrument department of Chemical Plant Division.

High salaries, pension scheme. Grant towards removal expenses and living allowance until removal is effected.—Apply, The Power-Gas Corporation, Ltd., Stockton-on-Tees. E6147 A

ASSISTANT ESTIMATOR REQUIRED for the London office of a large firm of engineers. Knowledge estimating and engineering experience essential. Full details of age, qualifications and past experience. —BOX No. E6384, "The Engineer." A

SITUATIONS VACANT

APPLICATIONS ARE INVITED for the following appointments at the CLAYDON, SUFFOLK, Works of
THE BRITISH STEEL PILING CO., LTD.
SENIOR DESIGNER DRAUGHTSMAN (Minimum qualifications H.N.C. or equivalent.) Age group 28–35 years. Candidates should be capable of accepting responsibility for complete projects.
MECHANICAL DRAUGHTSMAN (Young) (Minimum qualifications O.N.C.) Required for Research and Development Team.
THESE APPOINTMENTS ARE PERMANENT AND PROGRESSIVE IN AN EXPANDING ORGANISATION, and the successful candidates will be engaged on interesting work in connection with special crane type structures, hoisting machinery (steam, diesel, electric) and contractors' plant.
Contributory pension scheme in operation. Good canteen facilities. Salary in accordance with qualifications and experience. The works are situated 15 minutes bus ride from the centre of Ipswich.—Applications to the Personnel Officer at the above address. E6404 A

ASSISTANT CHIEF DESIGNER

Engineering company of world-wide repute offers EXCEPTIONAL SCOPE to Engineer with Mechanical Engineering Degree and basic electrical knowledge, with at least five years' practical experience.

This is an opportunity to join a young and vigorous Management team in a rapidly growing organisation. Starting salary up to £1500 per annum. Assistance with removal expenses ; good pension scheme.

Applicants are invited to send full details of academic qualifications, experience to date and present salary.—BOX No. E6399, "The Engineer." A

ASSISTANT CIVIL ENGINEER required to supervise as part of a team the construction of various works being carried out in connection with an atomic energy establishment. Preference will be given to fully qualified applicants, but five years' site experience is essential. Salary £1250. Reply, giving age, qualifications and full particulars of experience. —BOX No. E1690, "The Engineer." A

ASSISTANT MECHANICAL ENGINEER with good general knowledge of Civil Engineering Plant and capable of sketching mechanical details for use of site Plant Manager, is required immediately for major harbour construction contract in WEST AFRICA.—Write, BOX E822, L.P.E., Romano House, 399/401, Strand, W.C.2. E6364 A

ASSISTANT TO TECHNICAL ENGINEER, age 21/25, must have some drawing-office experience ; O.N.C. in Mechanical Engineering desirable ; knowledge of hydraulics and/or automotive engineering an advantage.—Apply in writing, with full particulars and salary expected, to Secretary, E. P. Barrus, Ltd., 12–16, Brunel Road, London, W.3. E6383 A

ASSISTANT WORKS MANAGER required by well-established Paper Converting Company in North West London area. Candidates should be between the ages of 30 and 40 and have a sound mechanical engineering background with at least some knowledge of electricity. They should have also initiative and good administrative ability. The initial salary is up to £1500 per annum, according to qualifications and the prospects are excellent. Apply at first in writing, giving details of previous experience. —BOX No. E10, "The Engineer." A

BRITISH CELLOPHANE, LIMITED, BRIDGWATER, SOMERSET INVITES APPLICATIONS FOR ENGINEERING POSTS IN ITS RESEARCH AND DEVELOPMENT DIVISION, AS FOLLOWS :

MECHANICAL ENGINEERS

Applicants should be Graduates or A.M.I. Mech.E. or both, aged 25/50, and are required for :—

(a) Development of plant used for the manufacture of Polythene film. Practical experience must have included an engineering apprenticeship, post graduate experience in maintenance and construction of a light engineering character desirable, previous experience in the extrusion of plastic films an advantage. Ref. No. R66. Er.
(b) Development work on applying aqueous dispersons of polymers as coatings to cellulose films. Engineering apprenticeship essential, post graduate practical experience in construction of a light engineering character desirable, experience in methods of applying thin coatings would be an advantage. Ref. No. R67.Er.

Applications, giving details of age, past experience and qualifications, should be addressed to the Personnel Officer, quoting Ref. Nos. as shown. E6404 A

BRITISH HYDROCARBON CHEMICALS LIMITED, GRANGEMOUTH, have a vacancy for an ELECTRICAL DRAUGHTSMAN in the age group 25 to 40 years. Candidates should have attained, at least, the Ordinary National Certificate standard in Electrical Engineering and have had some experience on electrical power installations, including electrical diagrams, cable layout, switchgear and control gear associated with installations operating at 3·3kV. and 440 volts. There is a non-contributory pension scheme in operation. Applicants should give details of background and experience and all applications will be treated in confidence. —Replies to Administrative Officer, British Hydrocarbon Chemicals Limited, Grangemouth, Stirlingshire. E6331 A

SITUATIONS VACANT

BRITISH ENGINE BOILER & ELECTRICAL INSURANCE CO., LTD., 24, FENNEL STREET, MANCHESTER, 4

INSPECTORS OF BOILER AND ENGINE PLANT required for various districts. Permanent positions carrying progressive salary scale £735 to £1060 and non-contributory pension. Candidates, age not exceeding 32 years, having steam boiler and engine experience and possessing at least 1st Class M.O.T. Certificate, are invited to apply in own handwriting, stating age, qualifications and experience. E6336 A

BRITISH OXYGEN GASES LIMITED

require a qualified

ELECTRICAL ENGINEER

for work in their Sales Technical Department.

The work is in connection with prototypes of electrical power units used in connection with electrical welding equipment. A young Engineer who has recently qualified, having completed a good apprenticeship, and wishes to pursue a commercial career, would be suitable. Age range 24–30.

Write, giving details to Personnel Manager, Spencer House, 27, St. James's Place, London, S.W.1. E6355 A

BRITISH PETROLEUM COMPANY, LTD., requires a CIVIL CONSTRUCTIONAL ENGINEER. Applicants, aged 28–40, should have B.Sc. or A.M.I.C.E., with field experience on construction of civil or mechanical projects, preferably with contractors in a supervisory capacity, and be accustomed to organising works sections with some knowledge of preparation of contract documents and control of expenditure. Successful candidate will be required to undertake tours of duty overseas. Salary according to age, qualifications and experience. Pension fund. Kit allowance and generous allowances payable when serving overseas.—Write, giving full particulars, quoting H.4108, to BOX 5702, c/o 191, Gresham House, E.C.2. E6340 A

BRITISH PETROLEUM COMPANY, LTD., requires a DISTRIBUTION ASSISTANT for service initially in IRAQ. Applicants, aged 30–40, should preferably have a University Degree and must have experience in the distribution of petroleum products and control of oil installations and retail outlets. Experience of the Middle East would be of particular advantage. Attractive salary plus generous allowances in local currency, kit allowance, pension scheme, good leave arrangements, free passages out and home.—Write, giving full details of qualifications and experience, quoting F.556, to BOX 3064, c/o 191, Gresham House, E.C.2. E6423 A

BRUCE PEEBLES AND CO., LTD., require Two ENGINEERS of H.N.C. standard for their Transformer Sales and Contracts Department, 5-day week. Staff pension and bonus schemes.—Apply, giving details of training and experience, to Manager, Transformer Dept., East Pilton, Edinburgh. E6362 A

CAREERS IN WORK STUDY

The London Branch of The British Oil and Cake Mills. Ltd., part of the Unilever Concern, invites applications for two appointments as WORK STUDY ENGINEERS.

Preference will be given to men aged 27 to 35 who have at least the H.N.C. in Mechanical Engineering (preferably with Endorsements in Industrial Administration and Work Measurement) and with a minimum of 5 years' practical experience in the field of work study. Considerable importance is attached to finding men with such personal qualities as will, in the company's opinion, enable them to pursue a successful career in this particular field.

The starting salaries offered will accord with the qualifications and experience of the selected applicants, who will be required to pass a medical examination and to join the superannuation fund.

Applications (which will be treated in strict confidence), giving fullest possible details of personal history, qualifications, experience and present salary, should be addressed to the Personnel Manager, The British Oil and Cake Mills, Limited, Albion Wharf, Erith, Kent. E1687 A

CHIEF ENGINEER

A large and expanding food company of international repute have a vacancy for a Chief Engineer to take executive responsibility for a modern food processing plant, employing 1400, located on Merseyside.

The post carries responsibility for all aspects of engineering, including maintenance and installation of plant, equipment and buildings. All services, including large-scale refrigeration and air conditioning. Efficient operation of processing packaging and bottling equipment.

Applicants should possess University Degree in Engineering, or its equivalent, and have had considerable experience in a similar capacity. The post, which is superannuated, offers a good salary and considerable scope.

Write, giving full details of age, qualifications and previous experience, to Personnel Manager, BOX No. E1693, "The Engineer." A

CIVIL ENGINEER INSPECTOR required to supervise works as part of a site team under direction of construction engineer. Experience in all types of R.C. work, quality controlled concrete, drainage, earth and road works, essential. A working knowledge of structural steelwork advantageous. Salary £900 inclusive. Reply, giving age, particulars of qualifications and experience.—BOX No. E1691, "The Engineer." A

SITUATIONS VACANT

CHIEF EXECUTIVE ENGINEER

required by a major British industrial group with headquarters in London. Responsible to Managing Director of the group for the overall control of wide field of engineering activities.

Candidates require sound mechanical engineering qualifications and experience in senior executive positions in the engineering or chemical industry.

Aged 35/48. Commencing salary £5000.—Applications, in strict confidence, stating experience and positions held, to BOX No. E6427, "The Engineer." A

CIVIL ENGINEERS AND DESIGN DRAUGHTSMEN with experience of reinforced concrete design, required in the Bristol and other offices of a National Established Engineering Consultancy. These are permanent, pensionable appointments, carrying attractive salaries and, in some cases, accommodation allowance. Reply with full details.—BOX No. E6192, "The Engineer." A

CIVIL ENGINEER, CHARTERED, with experience as Clerk of Works for important new chemical project in Northern Ireland. Wanted at once. Eighteen months' contract. Apply, giving full particulars of age and experience.—BOX No. E6398, "The Engineer." A

CIVIL/STRUCTURAL ENGINEERS, with extensive experience in design of power station and heavy industrial structures, required by Consultants. Starting salaries from £1200 to £1600 p.a.—BOX No. E6410, "The Engineer." A

CONSULTING ENGINEERS in Westminster have vacancies for :

(a) MECHANICAL ENGINEER, A.M.I.Mech.E. or Grad.I.Mech.E. Applicant should have wide general experience to allow him to undertake interesting and varied work.

(b) DRAUGHTSMAN OR WOMAN. This post covers many aspects of simple engineering drawing and layout work.

Salaries offered will be related to age and experience and a non-contributory pension scheme is available.—Replies, marked "Confidential, to BOX No. E6414, "The Engineer." A

DEPUTY required for the Mechanical Superintendent of an open-cast Mining Establishment in WEST AFRICA. A man with a wide background of mechanical experience in repair, maintenance, organisation and supervision of engineering activities required. The companies' interests include ore handling facilities and conveyors, a railway with diesel traction, earthmoving equipment, &c. Salary in the region of £1800 p.a., according to experience. Marriage and children's allowances, contributory pension and dependants' income schemes, free furnished accommodation and medical attention.—Write, giving full details of experience, stating age, married or single, to BOX TE.149, c/o 191, Gresham House, E.C.2. E6408 A

CO-ORDINATION AND MECHANICAL ENGINEER required for London office work. Applicants should be thoroughly familiar with major power station construction, both in the design stages and at site. Membership of a professional institution an advantage. Good salary and prospects. Pension fund.—Write details age, qualifications and experience (I.A.M./80), BALFOUR, BEATTY and CO., LTD., 66, Queen Street, London, E.C.4. E6422 A

DESIGN ENGINEERS

Men, of Degree standard, capable of undertaking design work in connection with large turbo-generating plant, are required by well-known Heavy Engineering Company for posts in North-East England and in London.

The design team is being reinforced in order to keep abreast of the rapidly expanding activities of the company, and these vacancies offer real opportunity to men of suitable calibre.

Salaries are good and Pension and Life Assurance Schemes are in operation.

Write in confidence.—BOX No. E6333, "The Engineer." A

DEVELOPMENT ENGINEER

WALLS, a food company within Unilever, with expanding production units in West London, require an Engineer (A.M.I.Mech.E. or B.Sc. (Engineering)), of not more than 42 years, whose duties will include development and installation of new plant layout and supervision of new building work. Progressive salary, starting in the region of £1150 per annum, with comprehensive superannuation and sickness benefit schemes—three weeks' annual holiday.—Write, quoting ref. No. 153, and brief personal details, applying for application form, to Company Personnel Manager, T. Wall & Sons (Meat Products), Ltd., Atlas Road, London, N.W.10. E6356 A

DIVISIONAL HOME SALES MANAGER, to organise the sale of machinery through merchant trade, required by well-known engineering firm in Midlands, making machinery for builders and contractors. Experience of selling through distributors, and market research, and handling of sales correspondence. Write in confidence, stating age, experience and where gained, salary required.—BOX No. E1679, "The Engineer." A

DRAUGHTSMAN required for Development Work on special purpose machinery. Wide knowledge of mechanisms essential. Applicant should be aged 23/25 years and have O.N.C. 5-day week. Sick and pension fund.—Apply in writing to Personnel Officer, Osram Glass Works, East Lane, Nth. Wembley. E6269 A

DRAUGHTSMAN, £950 p.a., required for pipework design/layout/detail work in Bristol. Boiler pipework experience essential. Pension scheme.—BOX 2899, Blackford's Advertising, Bristol. E6397 A

DRAUGHTSMEN, MECHANICAL ELECTRICAL, for Engineering Consultants. Knowledge of power station work an advantage. Positions permanent, pensionable ; five-day week, free lunches.—Write or 'phone Personnel Officer, EWBANK & PARTNERS, 10/11, Grosvenor Place, Hyde Park Corner, S.W.1. (Sloane 0486.) E6371 A

ELECTRICAL OR MECHANICAL ENGINEER experienced in power station design and construction, required in GLASGOW by Consulting Engineers, for planning of large NUCLEAR PROJECT. Degree or Associate Membership desirable.—Apply, Kennedy and Donkin (H.J.P.), 12, Caxton Street, London, S.W.1. E6406 A

ENGINEER.—An Engineer, aged 30–40, who can produce evidence of having first-class qualifications and experience, is invited to apply for an important position offering considerable scope for advancement. Practical experience of mechanical and electrical engineering, building and plant maintenance work and the ability to organise and control labour are essential qualifications. A knowledge of the rubber or plastics industry would be a decided advantage. A good salary will be offered in keeping with the position and responsibilities involved. Write in confidence, stating age, experience and qualifications.—BOX No. E6350, "The Engineer." A

ENGINEER

required in

DEVELOPMENT LABORATORIES

for stress analysis and vibration problems.

Applicants should have a good Degree in Mechanical Engineering, together with ability to make a mathematical approach to problems. Some experience in industry and in the use of electronic equipment is desirable.

The position carries an attractive starting salary and provides excellent opportunities for further advancement. Staff pension fund.

Apply in writing, stating age, qualifications and experience, to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/192. E996 A

ENGINEER REQUIRED for WEST AFRICA, for Operation and Maintenance of Vegetable Oil Producing Factory. Candidates, aged 26–33, must be of good education, at least qualified by examination for A.M.I.Mech.E. or equivalent, with good practical operating experience in charge of steam boilers and engines ; also diesel engines and plant maintenance, including small electrical installations. Post is one of responsibility for efficient processing, control of staff, training of Africans and includes upkeep of transport vehicles. Commencing salary would depend on qualifications and experience. In addition there are family allowances ; free furnished accommodation ; membership of pension fund ; free first-class passages to and from Africa and free medical attention in Africa. Tours of about 21 months are each followed by substantial leave on full pay. Please apply, giving all details of qualifications and experience.—BOX No. E6187, "The Engineer." A

ESTIMATOR

We are seeking to appoint an additional man to our Estimating Department to deal particularly with estimating costs of new products.

The man we have in mind would be aged about 30, have served an apprenticeship in light engineering, possess H.N.C., or be a member of a professional body ; have had some years production engineering experience, including work study and standard costs, in light engineering, electrical, mechanical and hydraulic products, and be sufficiently above average to enable him to prepare from experimental type drawings detailed estimated production costs. Commencing salary £900–£1150 per annum.

We are a nationally known company in light engineering, and the factory in which this vacancy arises is situated in a pleasant country area in the South. Conditions include a contributory pension scheme incorporating life insurance, and we think we have a record of fair dealing with our employees, a high proportion of whom have over 25 years' service.

A house at a reasonable rent can be made available, if necessary.

This is a key job and is part of the structure upon which we will depend for our future development and success. It represents a challenge and an opportunity to a man of ability.

Please write (in confidence) to the Chief Estimating Engineer, BOX 3E M.8359, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E6373 A

H. J. HEINZ CO. LTD., require the services of a MECHANICAL ENGINEER, aged 28–32, possessing A.M.I.Mech.E. or an equivalent qualification. Drawing-office and industrial experience is called for, preferably in factory plant layout and installations, service distribution, modern steam raising plant and auxiliaries, and industrial ventilation and heating systems. Candidates should also be accustomed to working with Consultants and Contractors. The position demands the exercise of initiative and energy and offers scope in an expanding industry. The company operates a non-contributory pension scheme and other welfare benefits.—Write, giving details of age, training and experience, &c., to Personnel Officer, at Harlesden, London, N.W.10. E6341 A

ESTIMATOR for progressive position with prominent London firm of land and marine boiler engineers. Drawing-office experience essential ; workshop experience an advantage. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, &c., BOX No. 1525/SE2, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4 E6232 A

EXPERIENCED CRANE DESIGNERS required in Glasgow. Minimum qualification H.N.C., preferably aged 30 or over. Commencing salary not less than £900 per annum. Pension scheme. Full details.—BOX No. E6417, "The Engineer." A

JUNIOR ENGINEERS, preferably with setting-out experience, urgently required for contract in the Liverpool area.—Apply, in writing, stating age, experience and salary required, to Peter Lind and Co., Ltd., Romney House, Tufton Street, Westminster, S.W.1. E6413 A

JOHN LAING AND SON, LIMITED, invite applications from

ASSISTANT SITE ENGINEERS

with experience of setting-out and general site engineering duties on a variety of important contracts in the British Isles. A Civil Engineering Degree or the equivalent is desirable but not essential.

Those interested should write to :—
Personnel Manager (A.S.E.1),
John Laing and Son Limited,
London, N.W.7. E6402 A

JOSEPH LUCAS (ELECTRICAL), LIMITED,

have vacancies for

ASSISTANT DEVELOPMENT ENGINEERS

to work on the design and development of automobile generators, alternators and starting motors and also of motor-cycle electrical equipment, including equipment to be used for racing purposes. Applicants should be of Higher National standard and should have had previous experience in electrical design. Five-day week, staff pension fund.

Apply in writing, stating age, qualifications and experience, to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/176. E995 A

MACHINE SHOP PLANNING ENGINEER required by a diesel engine manufacturing company. The successful applicant will be concerned with batch and flow production of engineering components. He must have experience of high production methods and knowledge of material, tool and labour costs an advantage. Excellent conditions of service and good salary will be offered to the applicant possessing the right qualifications.—Please apply in writing, giving full details of experience and salary required, to Chief Personnel Officer, Petters, Limited, Causeway Works, Staines, Middlesex. E6419 A

MECHANICAL DESIGNER sought by established manufacturer, in London, with world market for special-purpose precision machinery. Exceptional prospects for Qualified Mechanical Engineer having practical experience, aged 30–40, who is possessed of the "creative spark." Only applicant fertile in ideas, with original and inventive mind and receiving recognition in his present post on this account, need apply.—Write, in confidence, Personnel Manager, Molins Machine Co., Ltd., Evelyn Street, London, S.E.8. E6188 A

MECHANICAL DRAUGHTSMAN. — Large commercial and industrial organisation has vacancy in London head office for a Senior Mechanical Draughtsman. Applicants must have had extensive experience in layout of machinery and boilers, and possess a good all-round knowledge of general engineering. Some building experience would be an advantage. For the right man the prospects are excellent and there is a non-contributory pension scheme.—Write, giving age and details of experience, to BOX No E6321 "The Engineer." A

MECHANICAL MAINTENANCE ENGINEER, to assist Chief Engineer in plant installation and preventive maintenance in a medium-sized industrial organisation. State education, experience and salary required.—BOX No. E1694, "The Engineer."

NORRIS INDUSTRIAL CONSULTANTS, LIMITED,

require, for their Bristol Head Office experienced

1. (a) STRUCTURAL ENGINEERS, Reinforced Concrete or Structural Steelwork.
   (b) MECHANICAL HANDLING ENGINEER. Initial salaries within range £900–£1100 p.a.
2. (a) REINFORCED CONCRETE DESIGNER DRAUGHTSMEN AND DETAILERS.
   (b) STRUCTURAL STEELWORK DESIGNER-DRAUGHTSMEN AND DETAILERS. Initial salaries up to £875 p.a.

Permanent positions, pension and insurance schemes.—Write :
Personnel Manager,
Beacon House, Queens Road,
Clifton, BRISTOL, 8. E6315 A

Classified Advts. continued on page 124

BOOKS and PUBLICATIONS

"A complete library in two volumes.."

KEMPE'S

Engineers Year Book

Edited under the direction of the Editor of "The Engineer"

1958 (63rd Edition)

82/6 (plus postage 2/6d.)

JUST PUBLISHED

★ **3,000 pages covering modern theory and practice in all branches of engineering. No other single publication devoted to engineering covers a comparable range of subjects so concisely.**

ORDER YOUR COPY NOW

Obtainable direct from the publishers or through your local booksellers

Kempe's Engineers Year - Book

28 Essex Street, Strand, London, W.C.2

Telephone: Central 6565

SITUATIONS VACANT

METHODS AND PLANNING ENGINEERS

Applications are invited from men with progressive ideas and practical experience, for work offering scope for initiative. Applicants should have a good general engineering background, a knowledge of work study applications, machining methods, tool design and production planning.

The work also involves liaison with design offices to ensure that new designs are suitable for efficient and economical production. Salaries according to ability and experience. Generous pension scheme. Assistance towards moving expenses.

Applications, in writing, to the Personnel Manager, W. H. ALLEN SONS & CO., LTD., QUEENS ENGINEERING WORKS, BEDFORD. E6347 A

PLANT DEVELOPMENT DRAUGHTSMEN

The Stanton Ironworks Company, Limited, requires Development Draughtsmen, with experience of plant layout associated with heavy industry and preferably covering blast-furnaces, coke ovens, raw materials preparation and similar plants.

STEAM AND POWER PLANT DRAUGHTSMEN

There are also vacancies for Senior Draughtsmen with experience of ancillary equipment and layout associated with high-pressure boiler and turbine plant installations.

All posts are permanent and there is a pension scheme.—Applications, which will be treated in strict confidence, should state positions held, technical qualifications, and general experience, and should be addressed to the Staffing Officer, The Stanton Ironworks Company, Limited, P.O. Box No. 3, Near Nottingham. E6361 A

PRODUCTION ENGINEER. The United Glass Bottle Manufacturers, Limited, Charlton Works, London, S.E.7. Our Charlton works, one of the largest in the company, and employing over 2000 people, requires a Production Engineer, age 30–40, to assist the superintendent of a shop engaged in the manufacture of high-precision mould equipment for the production of glass bottles in their factory, and others within this nation-wide group. The minimum qualification is H.N.C., preferably A.M.I.Prod.E. or A.M.I.Mech.E., and applicants should have a comprehensive knowledge of modern machine shop production techniques with at least five years' experience in a responsible supervisory role. The post is pensionable, offers excellent scope for drive and initiative, carries good prospects for future advancement and an attractive starting salary commensurate with the responsibilities involved.—Please write, giving full details of age, qualifications, experience and salary envisaged, to The Personnel Officer, The United Glass Bottle Manufacturers Limited, Anchor and Hope Lane, Charlton, London, S.E.7. E1670 A

PRODUCTION ENGINEER and Assistant to the Managing Director required by small progressive engineering firm. Excellent opportunity for young engineer with initiative, and willing to accept responsibility.—BOX No. E6084, "The Engineer." A

PRODUCTION ENGINEER—an opportunity for a man with drive and the ability to accomplish improvements in the manufacture of coated textiles and rubber and plastic mouldings. Salary £1000–£1200 per annum, with eligibility for pension scheme. Head office in the Manchester area.—BOX No. E6365, "The Engineer." A

PUBLICITY DEPARTMENT

A competent man is to be appointed by an important firm in the field of building and engineering materials in the Manchester area. He should have experience of technical advertising and publicity in an industrial concern and be conversant with the preparation and supervision of printed matter, exhibitions, editorials, &c. Initial salary dependent upon age and capabilities but not less than £800 p.a., with every prospect of progressive advancement.—BOX No. E6297, "The Engineer." A

QUALIFIED ENGINEERS WITH INTEREST IN MANAGEMENT

Owing to the expansion of the Production Department of large factory manufacturing prestressed concrete products, vacancies exist for qualified Engineers.

The following qualifications are preferred :—

1. Age 25/35.
2. B.Sc. Degree and/or A.M.I.C.E. or A.M.I.Mech.E.
3. Strong character, personality, and initiative.
4. Interest in management practice.

Where necessary, training will be given. Excellent opportunities exist for advancement.

Applications, giving full particulars, should be addressed to :
Personnel Officer,
COSTAIN CONCRETE CO., LTD.,
Newmains,
Lanarkshire,
Scotland. E1683 A

REQUIRED, DRAUGHTSMAN, with experience in industrial diesel locomotive design. Must hold H.N.C. or similar. Vacancy is in London area. —BOX No. E6284, "The Engineer." A

RESIDENT ENGINEER REQUIRED for mechanical and plant erection work on new oil refinery and chemical plant construction. S ould be experienced in use of heavy lifting equipment, pipelines, &c., and control of labour. Commencing salary up to £2000 p.a., according to experience and qualifications. Please write in confidence, giving full details of past employers and contracts carried out.—BOX No. E6320, "The Engineer." A

RICHARDSONS WESTGARTH (HARTLEPOOL) LIMITED

have vacancies on their permanent staff for

DRAUGHTSMEN

with experience of turbo-generating and associated plant. The Draughtsmen are required initially for special duties in the company's office in Switzerland, where they will work in close co-operation with the staff of Brown, Boveri & Co., Ltd., at Baden. These are interesting posts for men wishing to extend their experience. A good salary and adequate allowances will be paid.

Write, in confidence, quoting reference H.–3, to the Group Personnel Officer, Richardsons Westgarth & Co., Ltd., P.O. Box 2, Wallsend on Tyne. E6334 A

ROLL DESIGNER, aged 30–40 years, required for large steelworks in the Midlands with expansion scheme in progress. Previous experience of small sections desirable. Staff position ; pension and free life assurance schemes in operation. Full details of age, qualifications and experience.—BOX No. E6349, "The Engineer." A

ROLLING MILL ENGINEER required in an integrated iron and steel works. Applicants should be educated to at least Higher National Certificate standard in Mechanical Engineering, and have experience of steelworks or heavy engineering maintenance. Candidates should be preferably between 30–40 years of age.—Forms of application are available from the Labour Officer, Richard Thomas and Baldwins, Limited, P.O. Box No. 7, Redbourn Works, Scunthorpe, Lincs. E6424 A

SALES MANAGER required by a large well-known engineering firm in Manchester area. The position carries full responsibility for the company's sales of foundry products, machine tools, and jig and tool equipment, and control of sub-contract work. Applicant should be aged 35–40 ; full technical knowledge of foundry and engineering industry essential. A four-figure salary will be paid and conditions of service include a contributory pension scheme. Applicants should give full particulars of education, past experience, qualifications and age.—BOX No. E1686, "The Engineer." A

SALES MANAGER (ENGINEERING).—Exceptional opportunity with London concern having interests in every branch of engineering and science. Must have sound practical and technical training ; membership of at least one professional engineering institution ; current experience in sales promotion, management and organisation. Attractive salary and conditions. Age 35–50.—BOX No. E6342, "The Engineer." A

SALES MANAGEMENT

Sales Director of major industrial group wishes to recruit a young man aged 30–35 years, with an Engineering Degree, who has the potential to develop rapidly within a large sales organisation. The Sales Division sell to industry a technical process and it is necessary for candidates to have had similar experience. After a period of six months' training an appointment will be made to a middle managerial position. Thereafter the prospects are extremely bright. Financial assistance in connection with housing is available. Write, stating full details of age, qualifications and experience.—BOX No. E6357, "The Engineer." A

SECTION LEADER, ELECTRICAL DRAWING-OFFICE

required by The Steel Company of Wales, Ltd. (Steel Division), Port Talbot.

The successful candidate will be expected to take charge and supervise an office of fifteen electrical draughtsmen. He should have experience in heavy industry and be capable of preparing drawings for electrical installations, including the layout of sub-stations and contactor rooms. A knowledge of lighting and communications would be an advantage.

Higher National Certificate or equivalent desirable.

Those wishing to apply should write, giving full details of age, experience, qualifications and present salary, to :

Superintendent, Personnel Services,
THE STEEL COMPANY OF WALES, LTD.
(Steel Division),
Abbey Works,
PORT TALBOT, Glam. E6313 A

SENIOR DESIGN ENGINEERS AND DESIGN DRAUGHTSMEN, experienced in industrial electronics or light precision mechanisms, required for permanent appointments in London, Bristol and the Home Counties. Salary and allowance in the range £900–£1200 per annum. Pension scheme.—BOX No. E6316, "The Engineer." A

SENIOR DRAUGHTSMAN, must have wide knowedge of latest practice in design of light to medium mechanical handling equipment, especially conveyors and elevators ; 5-day week, pension scheme, salary above A.E.S.D. minimum.—BOX No. E1677, "The Engineer." A

STEEL FABRICATING SHOP in the East Midlands has a staff vacancy for a FOREMAN and ASSISTANT FOREMAN. Applicants must be accustomed to modern fabricating methods and have had experience in a similar capacity.—BOX No. E1678, "The Engineer." A

STRUCTURAL DRAUGHTSMEN AND CHECKERS required in South West England. Good conditions. Pension scheme. Apply.—BOX No. E6234, "The Engineer." A

SITE ENGINEER

A qualified Engineer is required to take complete charge of the erection of important contracts for turbo-generating and associated plant at nuclear power stations in U.K.

This appointment carries responsibility for the planning, supervision and control of all erection work on site, and for acting on a senior level as the company's Representative on site. Previous experience with large turbo-generating plant in a supervisory capacity is necessary for this important appointment, which offers good salary and prospects to the right man.

Reply in strict confidence.—BOX No. E6332, "The Engineer." A

TECHNICAL AUTHOR (Instruction Books), for Central London. Able prepare, in good English, accurate descriptions mechanical/hydraulic subjects from basic details and drawings. Current engineering experience essential. Good salary and prospects.—BOX No. E6418, "The Engineer." A

TECHNICAL MANAGER, to take complete charge of new Rail Track Fabricating and Installation Department. Competent draughtsman with sound knowledge of permanent way engineering, preferably British Railways trained ; good commercial knowledge and outlook ; excellent opportunity for young man with initiative to create for himself a sound, progressive position. Car provided.—Applications, in the strictest confidence, will be considered in writing or by telephone by Managing Director, Pittrail Limited, Rly. and Civil Engineers, Caledonian Works, Aldridge, Staffs. E1685 A

TECHNICAL SALES MANAGER UNIVERSAL FURNACES LIMITED

The company is a subsidiary of the West Midlands Gas Board and works in close association with the Industrial Development Laboratories of the Board in Birmingham.

The Directors wish to appoint a young man with a sound background of fuel technology and a flair for sales promotion, to develop the sales of specialised gas-fired industrial appliances.

Commencing salary will be dependent upon previous experience and qualifications, but will not in any case be less than £1000 per annum.

The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications, stating age, qualifications and experience, together with details of present and previous appointments, and the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15.

J. SWAN,
Secretary to the
E6412 A West Midlands Gas Board.

TECHNICAL SALES REPRESENTATIVE required by large firm power transmission engineers, London area. Applicants must have practical drawing-office and workshop experience ; sales experience not essential. Full details age, qualifications and past experience.—BOX No. E6385, "The Engineer." A

THE G.K.N. GROUP RESEARCH LABORATORY requires a PHYSICIST or METALLURGIST, preferably with electrical experience, to control projects in the welding field. The post requires a capacity for original work and the exercise of initiative. The laboratory serves all the companies of a large group, and is well equipped for fundamental research and development. Ample opportunity exists for contact with Group companies, and research activiites are extending. Applicants, who should be of Degree standard, are assured of good working conditions. Salary scales are attractive.—Please write to the Director of Research, G.K.N. Group Research Laboratory, Birmingham New Road, Lanesfield, Wolverhampton, and quoting reference EE/W/3. E6319 A

THE MOTHERWELL BRIDGE AND ENGINEERING CO. LTD.

offer a first-class opportunity to a

SENIOR DESIGN ENGINEER

through their work on Atomic Power Stations and expansion in the production of Storage Tanks, Floating Roofs and Pressure Vessels for the Petroleum Industry.

Candidates must be Graduates with mechanical or civil background and sound practical experience in design and structural work.

A real ability to develop and execute original schemes is required. The work will include problems on Nuclear Reactors and associated plant construction.

The Motherwell Bridge and Engineering Co., Ltd., have recently completed the design, fabrication and erection of the Dounreay Reactor Sphere, and are members of the G.E.C.–Simon-Carves Group for undertaking work on Nuclear Power Stations. This Group has recently been awarded a contract with the South of Scotland Electricity Board for

THE ATOMIC POWER STATION

to be built at Hunterston, Ayrshire.

Applications, giving details of age, qualifications, and previous experience, should be sent to The Motherwell Bridge and Engineering Co., Ltd., P.O. Box 4, Motherwell. E6401 A

WANTED, CHARGEHAND MAINTENANCE FITTER, required for bottling factory of brewery company in North-East Coast area. Applicants should have first-hand knowledge of modern bottling machinery and mechanical handling plant, and be capable of controlling maintenance staff.—BOX No. E1682, "The Engineer." A

THE BRITISH STEEL PILING CO., LTD., require a CIVIL ENGINEERING ASSISTANT, aged about 25 to 30, for their London office. The work will involve the design of steel sheet pile retaining walls for all types of civil engineering structures, as well as cofferdams and bearing pile foundations. An Engineering Degree or equivalent qualifications are required. Previous experience of steel piling and soil mechanics is not essential, though desirable.—Apply in writing only, giving details of qualifications and experience, and stating age and salary required, to the company at 10, Haymarket, S.W.1, marking the envelope "Engineering Assistant." E1681 A

VACANCIES HAVE ARISEN IN AFRICA for Two or Three SALES ENGINEERS, to take Charge of Departments of a Merchant Organisation handling a wide range of electrical goods. Essential requirements are experience of domestic, commercial and industrial electrical installations, coupled with a genuine interest in selling and a flair for administration. Professional qualifications and experience of domestic appliances would be an advantage but not essential. Rapid expansion of business is anticipated and there should be ample opportunity for advancement. Commencing salary in the range of £1200 to £1600 per annum, with generous allowances and U.K. leave, depending upon the location and the qualifications offered by the candidate. Apply, giving full particulars.—BOX No. E6344, "The Engineer." A

WORK STUDY ENGINEERS

Ashmore, Benson, Pease and Company require Work Study Engineers for standards development in the machine shops (floor area about 150,000 sq. ft.) which form part of new workshop extensions.

The staff appointed will form part of a team of engineers working on the planning, progress and shop loading system who, on completion of the development work, will transfer to the production engineering staff.

Applicants should have a thorough training in work study techniques and experience of applying them to general engineering work in heavy and medium machine shops.

Engineers interested in joining the team on this project should write stating qualifications and salary required, to : Staff Personnel Manager, Ashmore, Benson, Pease and Company, Stockton-on-Tees. E6238 A

YOUNG MEN, aged up to 28 years, required to train for MANAGEMENT positions in large steelworks in the Midlands. Applicants must be in possession of O.N.C. (Mechanical) or higher ; preference will be given to those with H.N.C. An expansion scheme is in progress and excellent prospects are offered to selected applicants. Staff position ; pension and free life assurance schemes in operation. Full details of age, qualifications and experience.—BOX No. E6348, "The Engineer." A

SHELL

SHELL PETROLEUM COMPANY LIMITED

has a vacancy for a young

CIVIL ENGINEER

to assist with work on the applications of bitumen. This involves the study of a wide range of practical problems in road and civil engineering through Shell Group's world-wide markets. It will appeal to those men who can apply the findings of research to the development of new uses and improved applications in industry.

Candidates should preferably hold either an Honours Civil Engineering Degree or A.M.I.C.E.—age not exceeding 32 years.

The salary offered will be commensurate with experience and qualifications.

Please reply to :
STAFF DEPARTMENT (R)/CE.,
THE SHELL PETROLEUM COMPANY, LIMITED,
ST. HELEN'S COURT,
GREAT ST. HELEN'S,
LONDON, E.C.3. E6382 A

JUNIOR CHEMICAL ENGINEER

CHEMSTRAND LIMITED

have a vacancy in their works at Coleraine, Northern Ireland, where their acrylic fibre "ACRILAN" will be produced, for a young CHEMICAL ENGINEER who is keen on obtaining plant engineering experience. Should have 2/3 years' industrial experience and preferably a mechanical background. Starting salary £800 p.a. upwards, according to age and experience. Pension scheme. Career prospects.

Apply in confidence, with brief personal and career details and current salary, to Staff Personnel Manager, Chemstrand, Ltd., 8, Waterloo Place, London, S.W.1.

E6370 A

SITUATIONS VACANT

WORKS MANAGER

A progressive, expanding manufacturing organisation in South Yorkshire wishes to appoint a Works Manager for its well-equipped plant, which employ 800 personnel. Candidates should have considerable experience of factory management in the field of precision turning, grinding and assembly. This appointment carries a very attractive salary, together with excellent conditions of service, and the successful candidate will be a member of the top management team. Responsible to the General Manager.—Please reply, giving full details of age, present salary, experience and qualifications, which will be treated in the strictest confidence, to the Managing Director, BOX No. E6363, " The Engineer." A

ALEXANDER STEPHEN & SONS, LIMITED,
SHIPBUILDERS AND ENGINEERS
have vacancies in their
ENGINEERING DEPARTMENT
for
HONOURS GRADUATE AND H.N.C. MECHANICAL ENGINEERS
for design study and development work on progressive marine machinery installations of all major types.
Age 26–32 preferred, with marine or heavy engineering experience.
Apply, giving particulars to :
The Secretary,
Alexander Stephen & Sons, Ltd.,
Linthouse, GLASGOW, S.W.1.
E6337 A

MSL

have been retained to advise on the appointment of a

MANAGER (MANUFACTURING)

for a large company manufacturing diesel and electric locomotives. The division engaged on this work is one of a larger group which has recently embarked on a major re-organisation and re-equipment programme.

The appointment carries responsibility to the Managing Director for the administration of a works of approximately 800,000 sq. ft. and will entail careful planning during the development stage.

Candidates, who should possess a degree or other professional qualification in mechanical engineering, must have a wide experience of production planning and works management in medium/heavy engineering industry and have proved organising ability. Experience in this industry is not essential, although it would be an advantage.

Preferred age 40–45. Salary up to £3,000 according to experience, plus bonus.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.852, to M. B. Berks.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.
E6368 A

B.I.C.C. LTD, LEIGH,

have the following vacancies :—

MECHANICAL ENGINEERING AND PLANT LAYOUT DRAUGHTSMAN, 25/35 years of age, with good engineering background. Experience in general cable-making machinery detailing and/or cable factory plant and services layout, whilst not being essential, would be an advantage. Five-day week. Salary A.E.S.D. plus, according to qualifications and experience.

DESIGNER-DRAUGHTSMAN IN THE PLANT DEVELOPMENT SECTION, RUBBER CABLES DIVISION, for work in prototype machines, &c. Appointment offers excellent prospects to a man with a flair for design work and capable of following the projects to a production stage with minimum supervision. Applicants, preferably between the ages of 30/40 years. Mechanical Engineering qualification to H.N.C. standard (or equivalent) would be an advantage. Five-day week.

Written applications, stating salary required, age, experience and qualifications, should be addressed to the Personnel Officer, British Insulated Callender's Cables, Ltd., Anchor Works, Leigh, Lancs.

E6266 A

DESIGNER-DRAUGHTSMEN

Kellogg's design capacity increased substantially in 1956 compared with 1955. In 1957 it was more than double that of 1955. This indicates that we offer the oil and chemical industries *something* to account for these increases in the volume of our work and in the size of our staff to handle it. That " something " is greater process know-how, more solid design experience, speed and efficiency, and a record of achievement in our business of which we are proud. If you are qualified, you can join our team. Our knowledge and our high standards of engineering work will then help in your own development !

PIPING
INSTRUMENT
ELECTRICAL
PRESSURE VESSELS
HEAT EXCHANGERS

Owing to increased demands for our services, Designer-Draughtsmen in these categories are cordially invited to contact KELLOGG INTERNATIONAL CORPORATION, leading Design and Construction Engineers of world-wide repute in the petroleum and chemical industries. Our permanent staff benefit from above-average salaries, liberal personnel benefits, good working conditions with opportunities for advancement, and excellent Social Club.

Our Designer-Draughtsmen are of a high standard and we therefore can consider only men of equal calibre. We have immediate vacancies in our new additional premises, so if you qualify and are interested, you are invited to write to, or telephone, the Personnel Manager,

KELLOGG
INTERNATIONAL CORPORATION
7-10 CHANDOS ST., LONDON, W.1. Tel.: MUSeum 4010, quoting ref. 126/G
E6394 A

DAVY AND UNITED ENGINEERING COMPANY LIMITED

The following vacancies in Britain's largest organization of Rolling Mill and Auxiliary Plant Manufacturers are open to ambitious qualified men interested in heavy engineering. All contracts, irrespective of size, have to be individually engineered, offering a wide range of interest and unlimited scope for ingenuity and initiative.

PROJECTS ENGINEERS

Engineers are required with experience of steel and non-ferrous rolling mills of all types. They will be responsible for engineering machinery prior to tendering. Items range from individual units to complete rolling mill plants.

RESEARCH ENGINEERS

Graduate Mechanical Engineers are required to join an Expanding Research Department to collect and collate performance and test data from installed plant and from models of new designs.

DEVELOPMENT ENGINEERS

Development Engineers are required to fill vacancies in an expanding department. Applicants should have experience in the design or operation of heavy capital plant and should preferably be qualified as A.M.I.Mech.E., but consideration will be given to suitable Graduate Members. Separate workshop facilities are provided for building prototypes and models for testing and specialised assistance is available from the Research Department.

Excellent working conditions in modern building, medical, canteen and sports facilities, contributory superannuation scheme.

Apply in writing, with details of age, experience, qualifications, &c., indicating sphere of interest, to : Dept. E., Personnel Department, Davy and United Engineering Co., Ltd., Prince of Wales Road, Sheffield, 9. E6387 A

MICHELIN TYRE CO. LTD.,

- **Stoke-on-Trent**
- **have progressive openings for**
- **DESIGNER/DRAUGHTSMEN**

(a) With H.N.C. and preferably Thermo-dynamics endorsement, for interesting work in connection with Works Services—boiler plant, steam and hydraulic applications, pipework.

(b) With H.N.C. (mechanical) and experience design of medium to heavy process plant. Some knowledge belt and chain conveyors desirable.

(c) With H.N.C. (electrical) or O.N.C., and now studying for H.N.C. for work on motor applications, lighting schemes and general factory electrical services.

Good commencing salaries, related to qualifications and experience, are offered, plus a contributory pension scheme, free life assurance and excellent welfare facilities.

Assistance with housing will be given if required.

Please write in confidence to :—(Mr.) A. C. McComble, c/o above, quoting reference B3/E.

E6351 A

Classified Advts. continued on page 126

SITUATIONS VACANT

Dunlop Rubber Company

AIRCRAFT TYRE DIVISION

Offer appointments for Tyre Design and Development work in this very active branch of the tyre industry. The work is interesting and varied, and there are good prospects of advancement within the organisation. Applicants should be aged 25–35 and have an Honours Degree in

ENGINEERING or MATHEMATICS

Some industrial experience is preferred but is not essential.

Selected applicants will be employed in the Aircraft Tyre Division, Fort Dunlop, Birmingham, where working conditions and recreational facilities are excellent. A Staff Pension Scheme is in operation.

Suitably-qualified Engineers and Mathematicians are invited to write in confidence, giving brief details of experience so far and commencing salary expected, to the :

PERSONNEL MANAGER (AT), FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24

E6378 A

C. A. Parsons & Co. Ltd.

NEWCASTLE-UPON-TYNE

CHIEF METALLURGIST

SENIOR RESEARCH METALLURGISTS

RESEARCH METALLURGISTS

SENIOR METALLOGRAPHER

ASSISTANT METALLOGRAPHERS

Applications are invited for these appointments in a **NUCLEAR RESEARCH CENTRE** now being established on a new site in Newcastle-upon-Tyne, to provide the most up-to-date research and development facilities to meet the present and long-term needs of **THE NUCLEAR POWER PLANT CO., LTD.** The Metallurgical Laboratories are being planned to cover all aspects of nuclear fuels, canning materials and reactor steels. Special interest relates to Powder Metallurgy, Ceramics, Cermets, Zirconium, Magnesium, Niobium, &c., including methods of fabrication, oxidation, compatibility and behaviour under irradiation.

THE CHIEF METALLURGIST will be responsible for the planning and equipping of the new laboratories and on their completion will take charge of them with full responsibility for the initiation and supervision of research in his department.

He should have the highest technical qualifications and should have held a responsible position in a research organisation, preferably one devoted to nuclear work.

SENIOR METALLURGISTS.—Graduates, preferably with an Honours Degree and with research experience, who can take charge of a section or sections of the work of the department. They will be responsible to the Chief Metallurgist, but will have the maximum freedom consistent with departmental policy in directing the work for which they are given responsibility. Previous experience directly applicable to the scope of the work outlined is desirable, but not essential.

RESEARCH METALLURGISTS.—The work to be undertaken at the Research Centre and the facilities provided offer unique opportunities to metallurgists who wish to enter this new and expanding field. Applications will be welcomed from graduates with some years' research experience or from those completing their studies this year. Salaries will be in accordance with experience and ability to take responsibility.

SENIOR METALLOGRAPHER.—A metallographic department, complete with the latest equipment will serve the research centre. The Metallographer in charge is responsible to the Chief Metallurgist for ensuring that his department is staffed and equipped to provide a high-class service. This position is considered a most important one and only fully qualified men with considerable experience should apply.

ASSISTANT METALLOGRAPHERS.—The work in the Metallography Department covers a wide field of considerable interest and applications will be welcomed from technically qualified men or women.

GENERAL

The appointments are pensionable and successful applicants will be entitled to participate in the Company's Superannuation Scheme. Assistance with regard to housing can be provided where necessary. Since the Research Centre is only in the process of building, some latitude is possible as to the time at which an appointment —other than that of the Chief Metallurgist—is taken up.

Applications, giving full particulars of training, qualifications, experience and positions held, should be sent to The Research Director, C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-upon-Tyne, 6. If it is desired that the application be treated confidentially, it should be so marked. Further information will be gladly supplied on request.

E6369 A

SITUATIONS VACANT

A CAREER IN SOUTH AFRICA

AFRICAN EXPLOSIVES AND CHEMICAL INDUSTRIES LTD.

has vacancies for

professionally qualified
(Graduate or A.M.I.Mech.E.)

MECHANICAL ENGINEERS

INSTRUMENT ENGINEERS

in its organisation in South Africa. Recruits are required for plant production and maintenance work in the Company's three main factories located near Johannesburg, Capetown and Durban. Men under 35 years of age are more readily placed.

Many opportunities for advancement exist in this large and expanding company, which manufactures a wide range of products.

Conditions of service include :

(*a*) Three-year initial contract with payment of passages (including wife and children of a married man) and an expense allowance.

(*b*) Guaranteed accommodation for renting.

(*c*) Membership of Pension Fund and Medical Aid Society.

(*d*) Leave facilities which make provision for long leave at intervals.

Emoluments include a cost-of-living allowance, an annual bonus and regular increments for satisfactory work and service.

Further information and application forms can be obtained from Mr. L. H. F. Sanderson, Overseas Recruitment Officer, AFRICAN EXPLOSIVES AND CHEMICAL INDUSTRIES LTD., Imperial Chemical House, Millbank, London, S.W.1.

E6330 A

IMPERIAL CHEMICAL INDUSTRIES, LIMITED,

Billingham Division

and

Heavy Organic Chemicals Division

Careers for

MECHANICAL ENGINEERS

The new Heavy Organic Chemicals Division of Imperial Chemical Industries, Limited, was formed on 1st January, 1958, and certain of the works of the Billingham Division were taken over. This has meant an increase in the number of Mechanical Engineers required to fill the vacancies resulting from promotions and transfers and to undertake the expansion programme for both divisions.

A wide variety of engineering work is available, and the young engineer will have the opportunity to gain excellent all-round experience. There are immediate vacancies in design, research, work study and management. Post-graduate training on full salary can also be provided for graduates taking up a first appointment this year.

- ★ Attractive salary scheme. Profit-sharing, pension fund, subsidised canteens.
- ★ Assistance with house purchase and removal expenses for married men.
- ★ Substantial lodging allowance for married men for a period of up to six months.
- ★ Excellent social and games facilities.

If you hold a University Degree and are interested in the possibility of an appointment in either division, we invite you to write, giving brief details of age, qualifications and experience, to the Staff Manager, Imperial Chemical Industries, Limited, Heavy Organic Chemicals Division, Billingham, Co. Durham, quoting reference W/M/5.

E6393 A

SITUATIONS WANTED

DESIGNER-DRAUGHTSMAN, A.M.I.Mech.E., aged 34, experienced mechanical handling, conveyors, elevators, &c., seeks post with Executive prospects.—BOX No. E1675, "The Engineer." B

ENGINEER, A.M.I.Mech.E. (35), apprentice (toolroom) trained, experienced design and production on light and medium mechanical engineering, seeks position as Development or Production Engineer in similar field. London area, South and South-East suburbs.—BOX No. E1695, "The Engineer." B

ENGINEERING EXECUTIVE, with experience of compressors and associated equipment, seeks post where this experience can be utilised.—BOX No. E1688, "The Engineer." B

TECHNICAL REPRESENTATIVE/SALES, Yorkshire. M.I.Mech.E. offers representation of highest integrity.—BOX No. E1689, "The Engineer." B

BUSINESSES and PREMISES

TO LET, JUNE, 1958, Winchester District, between 100,000 and 150,000 superficial feet, suitable for research, industrial, administrative or storage purposes.—Apply, R. H. and R. W. Clutton, East Grinstead, Sussex. E6156 L

BUSINESS OPPORTUNITIES

VALVES.—Engineers with capital willing to Purchase Controlling Interest in Company manufacturing Valves. Replies will be treated in strictest confidence. —BOX No. E1666, "The Engineer." O

WANTED, New Products by a Canadian engineering company for manufacture and/or distribution in Canada. Licensing arrangement considered. Principals only.—Metro Engineering Co., Ltd., 102, Elmslie Street, Montreal, 32, Quebec, Canada. E1631 O

DRAWING & DESIGN SERVICE

FOUR DRAUGHTSMEN offer services at a competitive price in
TOOL & JIG DESIGN,
ELECTRO-MECHANICAL DESIGN,
TOOL & CAM LAYOUTS FOR BECHER, TORNOS, WICKMAN AUTOMATICS AND TRACING.
BOX No. E1674, "The Engineer." S

SUB-CONTRACTING

ACCURATE MACHINING

also on Models and Prototypes, &c.

MILLING TURNING
JIG BORING PLANING
PRESS TOOLS, JIGS AND FIXTURES
HORIZONTAL BORING

GIVE US YOUR DIFFICULT JOBS

LANDEN (ENGINEERS), LTD.
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075 E871 MW

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E575 MW

KELLERING and Profile Milling in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft. by 8ft. max. size. We are die copiers to the trade.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Tel.: Knottingley 2743/4). E948 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design and development undertaken. A.I.D. Approved.—Bowyer, Smyth and Partners, Ltd., Vineyard Walk, Clerkenwell E.C.1 ('Phone, TERminus 5113/4). E650 MW

The Specialist Foundry
with own machine shop
for
BLACKHEART MALLEABLE IRON CASTINGS
●
HEAT AND ABRASION RESISTING ALLOY CASTINGS
●
Manufacturers of the
'PULMAC' PULVERISING MILLS

FOLLSAIN-WYCLIFFE FOUNDRIES LTD.
LUTTERWORTH, Nr. RUGBY
Tel. 10, 60 & 152 E985 MW

AGENCIES

AGENTS required by material handling and aircraft ground servicing equipment manufacturers, all parts. On commission basis.—BOX No. E1627, "The Engineer." D

GENTLEMAN, RESIDENT IN MIDLANDS, is interested in negotiating SOLE AGENCY REPRESENTATION for reputable manufacturers in engineering field. Top quality products only; 27 years' engineering and executive experience. Highest qualifications, including M.S.M.A. Replies in confidence —BOX No. E6380, "The Engineer." D

MANUFACTURERS seeking to increase their sales in Scotland may secure reliable agents by writing with particulars to the Secretaries of the Scottish Association of Manufacturers' Agents who will advertise under a box number, in the Association News Letter.—Write to Dept. E., Hourston MacFarlane and Co., 5, St. Vincent Place, Glasgow, C.1. E962 D

PIPE FITTINGS.—Agent seeks company manufacturing Valves and/or Flanges, &c., who would be interested in ACTIVE REPRESENTATION in the London area.—Reply, BOX No. E1676, "The Engineer." D

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 ('Phone, SLOane 5259). E112 K

MISCELLANEOUS

PHOTOGRAPHIC SERVICES

A.S.P. (ENGINEERS), LTD., 129, Balham High Road, London, S.W.12 (Balham 3426), specialist photographers for the engineering industry. Photographic Work Undertaken, London Area, and 100 miles radius—architectural features, civil engineering and building work, machinery, models and transport, etc. Specimens available on request. E1630 I

MACHINERY Etc. WANTED

BALL AND ROLLER BEARINGS, &c., WANTED! Also Surplus Goods—especially Hand Tools—of All Descriptions.
FOR SALE: METAL BOXES of strong and sturdy gauge and construction, with Handles, in all sizes. Ask for details.
R. PORDES
138, NEW CAVENDISH STREET, LONDON, W.1.
MUSeum 5250. E6271 F

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Moseley Road, Birmingham, 12. VIC. 1278, 1279, 1270, 0856. E123 F

WANTED, Tube Expanding Machine, Tube Cleaning Machine, 6in. to 8in. Screwing Machine, with collapsible head.—Fred Watkins (Boilers), Ltd., Coleford, Glos. E997 F

FOR SALE

TWO NEARLY NEW POWERFUL CRANES

90-ton Electric Travelling Goliath Crane, 106ft. span, 72ft. lift, all lattice steel construction, electrics 400 volts, 3-phase, 50 cycles. Tested by Lloyds to 150 tons.

35-ton Electric Portal Wharf Crane, built 1945; 35 tons at 60ft. fixed radius, 85ft. height of lift, rail gauge 40ft. admitting 3 lines of standard gauge track, electrics 440/3/50, with Ward-Leonard generator.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works, Woolwich Industrial Estate,
London, S.E.18.
Telephone: Woolwich 7611/6.
E6390 G

MILLING AND HOBBING MACHINE

WANDERER Model 311. 1000 Universal Long Thread MILLING AND HOBBING MACHINE, for internal and external threads, helical and parallel splines, worms, &c.; length of hob spindle travel 39½in., height of centres 8½in., hollow spindle 3 3/16in. dia.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD LONDON, N.W.1
EUSton 4681 and 3771. E6185 G

VALVES VALVES VALVES

SPECIAL OFFER—BRAND NEW VALVES by leading manufacturers, Hopkinson, Audley, Saunder, &c., in Stainless Steel, Forged Steel, Enamel and Rubber-lined Valves and Cocks. All sizes from ¼in. to 12in. bore.
PRICES: well below list.
DELIVERY: immediate ex stock.
Also large stocks of STOP VALVES, Parallel Slide, Wedge Gate, &c., REDUCING VALVES, RELIEF VALVES. Sizes up to 24in. bore.
When its VALVES—remember
G. E. SIMM (MACHINERY) LIMITED.
27, Broomgrove Road, SHEFFIELD, 10.
Telephones: 64436 (3 lines) E6203 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel., Bexleyheath 305). E681 G

FOR SALE

FRED WATKINS (BOILERS), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic, 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Broomwade 510 cu. ft.; Tilghman 365 cu. ft.; Broomwade 300, 200 and 130 cu. ft.; all motorised.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib; 8½-ton Ransomes Diesel-Electric, 1948; 4-ton Coles Diesel-Electric; 3-ton Jones Super 40 (3); Neals 2-ton Diesel, 20ft. jibs (2); Derrick, 5-ton Butters Electric travelling type, 90ft. jib; 5-ton Wilson Electric, 70ft. jib; 3-ton Rushworth Electric, 65ft. jib; Steam Loco., 18-ton Brownhoist, 50ft. jib; 10-ton Coles, 40ft. jib; 8-ton Wilson, 35ft. jib; 5-ton Smith, 50ft. jib; 5-ton Cowans Sheldon, 50ft. jib; 5-ton Grafton, 38ft. jib; E.O.T. Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris; 10-ton Vaughan, unused, 40-60ft. span; 5-ton Henderson, 24ft. 7½in. span, 1946; 5-ton King. 29ft. 3in. span; 2-ton Morris, 18ft. span; 2-ton Smith, 34ft. span.
RAILWAY MATERIAL.—150 h.p. Stephenson Diesel Loco., fluid flywheel drive; Ruston 80/88 h.p. Diesel Loco., electric start, flameproof; Peckett 14in. by 22in. and 7in. by 12in. Steam Locos.; 3 miles 20 lb. Track, 24in. gauge bogies, turnouts locos., &c.
STEEL PIPING.—50,000ft., 2in. Galvanised new; 60,000ft., black new; 5000ft., 8in. seamless; 1000ft., 12in. seamless; 500ft., 14in. seamless; 400ft., 18in. riveted; 280ft., 21in. o.d. welded flanged; 3800ft., 21in. seamless flanged; 500ft., 24in. riveted; 1450ft., 27in. o.d. welded flanged; 216ft., 48in. riveted; 216ft., 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.
MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¾in.; Robertson Straightening Rolls, 8ft. 6in. by ¾in.; Berry Bending Rolls, 7ft. by ¼in.; Tangye 300-ton Hydraulic Horizontal Straightening Press, 15ft. by 3ft. table; Herbert 3ND Miller, 61in. by 15in. table; Pels Punch and Shears, ¾in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers.

SLING ENGINEERING WORKS,
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E366 G

VALES PLANT REGISTER LIMITED
OFFER FOR IMMEDIATE SALE
CRANES

One 1-ton Neals Mobile Crane, Ruston diesel engine, mounted on pneumatic tyres, 20ft. jib, fully slewing. In good order. £575.
One 2-ton NM Neals Diesel Mobile Crane. New 1950. Swan-neck jib, on pneumatics. In good condition. £1250.
One Jones "Super 40" 3-ton Diesel Mobile Crane, 24ft. jib, Ruston engine, on pneumatics. Ex Ministry. Overhauled. £1275.
One 4/6-ton "QM" Neals Mobile Crane, with 50ft. jib, on pneumatics. New 1955. In good condition.
One 5-ton Morgan Electric Derrick Crane, 120ft. jib, with or without bogies. Good condition.
Three 7-ton Butters Steam Derrick Cranes, 100/120ft. jibs, two machines of grabbing type. All in very good condition.
One 7-ton Butters Electric Derrick Crane, 120ft. jib, timber cabin, safe load indicator, &c. In good condition.
One 12½-ton Coles Petrol/Electric Fully Mobile Crane, with 45/80ft. jib. New 1950. Reconditioned recently. £5500.
Further details, 14, Lower Grosvenor Place, London, S.W.1. Telephone, Victoria 7513, 3501, 8080, 9886 (15 lines). E484 G

METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.
Motor and gearbox available separately if required.

JOHN CASHMORE, LTD.
Newport, Mon.
Tel.: Newport 66941 (6 lines).
E991 G

TWW

TAYLOR and CHALLEN 1573B DOUBLE-SIDED, GEARED, SINGLE-CRANK POWER PRESS, 120 tons capacity, 18in. stroke, bed area 24in. by 26in., self-contained 15 h.p. motor drive, 400/3/50.
TAYLOR and CHALLEN 1562 DOUBLE-SIDED, GEARED, SINGLE-CRANK POWERPRESS, 200 tons capacity, 36in. stroke, bed area 24in. by 22½in., self-contained 30 h.p. motor drive, 400/3/50.
BLISS 34B DOUBLE-ACTION TOGGLE PRESS, punch stroke 12in., distance between slides 26in., 400/3/50.

THOS. W. WARD LTD.
ALBION WORKS - - - SHEFFIELD.
'Phone: 26311. 'Grams: "Forward." E213 G

FOR SALE, Nordberg 36in. standard head Cone Crusher, with 60 h.p. totally enclosed slip-ring motor, vee drive. Only done approximately 150 hours since new. Accept £3750.
Saville-Calvert (Machinery), Ltd., Harvester House, Stratford-on-Avon (Tel.: 3681). E1692 G

FOR SALE

SOAG

HIGH CLASS VERTICAL AND HORIZONTAL BORING MACHINES IN STOCK

VERTICAL BORERS

SINGLE COLUMN TYPES

HARTMANN 43½in., motor drive, hexagonal turret head and side head, with square tool post, table dia. 39½in., max. swing 43½in., height admitted 27½in., 16 speeds 3–52 r.p.m.
NILES 40in., motor drive, hexagonal turret head and side head with square tool post, table diameter 31½in., height admitted 27in., spindle speeds from 3·5–70 r.p.m., h.p. 25.
WEBSTER & BENNETT 36in. D Type High Power Boring and Turning Mill, multi-motor drive, main table drive 15 h.p., rapid power traverse 3 h.p., 12 table speeds from 5·6–125 r.p.m.

DOUBLE COLUMN TYPES

RICHARDS 36in., motor drive, two swivelling tool rams, left hand fitted for screwcutting, table dia. 34in., max. swing 36in., height admitted 29in., 12 speeds, 2·5–60 r.p.m.
GISHOLT 42in., motor drive, two swivel tool heads, table dia. 40in., max. swing 48in., height admitted 33in., 12 speeds, 2–60 r.p.m.
SONDERMANN & STIER 6ft. 9in. KD20, motor drive, two swivel tool rams on cross rail, power rise and fall to cross rail, table dia. 72in., max. swing 81½in., max. height under cross rail 55in., 18 table speeds, 0·08–32 r.p.m.

HORIZONTAL BORERS

KEARNS "S" Collet Chuck Type, motor drive, table size 22in. by 16in. long, table traverse 24in., cross traverse 12in., vert. adjustment of spindle 12in., 6 spindle speeds, 65–500 r.p.m.
GIDDINGS & LEWIS 25RT Traversing Spindle, spindle dia. 2½in., spindle travel 27½in., max. distance spindle to table 28in., table size 24in. by 24in., max. distance spindle nose to outer stay 60in., speed range 15–400 r.p.m.
RICHARDS HB2. Traversing Spindle, spindle dia. 2½in., spindle travel 24in., max. distance spindle to table 34in., max. distance spindle nose to outer stay, 6ft. 6in., table size 39in. by 30in., speed range 16–400 r.p.m.
RICHARDS HB2A, Traversing Spindle, spindle dia. 3in., spindle travel 24in., max. distance spindle to table 34in., max. distance spindle nose to outer stay 84in., table size 48in. by 30in., speed range 16–400 r.p.m.
RICHARDS PRT.2N, with traversing spindle, continuous feed facing head, spindle dia. 3in., facing capacity 30in., vertical travel of spindle head 6ft., cross traverse of table 6ft., main table 7ft. by 3ft. 2in., top table 3ft. 2in. square, distance spindle to outer stay 7ft. 6in., h.p. motor 10.
SCHARMANN HBSF3, Table Type, motor drive, with travelling spindle, continuous feed facing head, spindle dia. 4in., facing cap. 39½in., working surface of table 47½in. by 55in., max. distance spindle nose to outer stay 102in., 24 spindle speeds from 4·7–960 r.p.m.
PEARN-RICHARDS No. 4, Standard Type, facing head only, max. facing capacity 48in., top table size 36in. by 36in., speed range 1·5–160 r.p.m.
WETZEL B110, motor drive, traversing spindle, continuous feed facing head, spindle dia. 4⅛in., rotating table 47in. by 55in., max. distance spindle to outer stay 1–18in., spindle speeds 5–500 r.p.m.

IT'S CHEAPER TO BUY NOW!

Full details on any of the above on request to:—

SOAG MACHINE TOOLS LTD.,
JUXON STREET, LAMBETH, LONDON, S.E.11.
'Phone: RELiance 7201.
'Grams: "Sotoolsag," London, S.E.11.
E210 G

600

READY FOR DESPATCH

TWO NEW 970kW., 11,000/3/50, HARLAND & WOLFF Diesel-driven Alternator Sets, direct-coupled at 333 r.p.m., engine 1400 h.p., vertical, 6-cylinder, 4-stroke, makers type 640SB, with all standard ancillaries, starting equipment. Alternator is totally enclosed with ventilating ducts and connected to water cooler. Switchboard including exciter control with automatic voltage regulator. Alternators can be reconnected for other h.t. voltages.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070; and
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E205 G

HYDRAULIC PRESSES

Large stock of modern Presses up to 10,000 tons capacity, for Forging, Forming, Extruding, Baling and other duties.
Enquiries from the Specialists:—
REED BROTHERS (ENGINEERING), LTD.,
Replant Works, Woolwich Industrial Estate,
London, S.E.18.
Tel.: Woolwich 7611 (6 lines).
E6388 G

NEW COLCHESTER "MASCOT" S.S. and S.C. Gap Bed LATHE. 8½in. H.C. by 54in. B.C. Price £898. Delivery immediately ex our London stock.—Welling and Welling, Ltd., 4, Victoria Street, London, S.W.1 (Tel.: ABBey 2341). E989 G

ONE GOOD SECOND-HAND 10-TON CRAWLER CRANE, by Thomas Smith and Sons, Rodley. Diesel engine driven, complete with jib, and separate diesel engine drive; 10kW generator for operating magnet. Serial number 17287.—BOX No. E6374, "The Engineer." G

Classified Advts. continued on page 128

FOR SALE

Edwards

JOHN HANDS Style SCG., No. 8 Double Geared, Double Sided Press with cast steel body, pressure exerted about 400 tons, stroke 8in., between uprights 26in., bed 24in. by 26in., arranged motor drive, weight about 10 tons.

Motorised Worm Geared Precision Guillotine, undercrank type, capacity 8ft. wide by ¼in. thick mild steel, gap in open ends 6½in., arranged motor drive 400/440/3/50, cam-operated automatic hold-down and all gauges, weight about 6½ tons.

New BRAUCHLI Model AS2050 × 8, All-Steel Motorised Hydraulic Guillotine, open-ended type, with tilting table enabling bevel cuts to be made from 0 deg. to 30 deg., capacity 6ft. 6½in. by ¼in. thick, drive to hydraulic pump from electric motor for 400/3/50, all gauges.

New STOELTING Pyramid Type Plate Bending Roller, motorised 400/440/3/50, capacity 10ft. wide by ¼in. mild steel, diameter of rollers, top, 9¼in.; bottom, 7¼in., drop end bearing for removal of completed cylinders, support rollers to bottom rolls, reduction gearbox drive to bottom rolls with multi-disc slipping clutches, motorised adjustment to top roller.

New BESCO Motorised Plate Bending Roller, capacity 6ft. by ¼in., dia. of top roller 5¼in., dia. of bottom rolls 4¼in., 380/420 volts, 3 phase, 50 cycles.

WESTON Model 400/100, Double Sided Friction Screw Press of steel plate construction, pressure about 120 tons, maximum stroke 11in., diameter of screw 6½in., maximum daylight, ram up, 11in., bed 21 ½in. by 18in., arranged motor drive, 380/420/3/50, weight about 5 tons.

Photographs of the above are available.

MACHINE TOOLS, NEW AND USED, Of Every Description. Attractive Prices.

F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
Telephone: EUSTON 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone: Central 7606–8. E207 G

OLDFIELD AND SCHOFIELD 33in. swing Heavy-Duty Surfacing and Boring Lathe, with 2 chucks, faceplate, screwcutting and power feed to compound slide. M.D. 400/3/50.—H. BELL (MACHINE TOOLS), LTD., WALTER STREET, LEEDS, 4. Tel.: 63–7398. E185 G

UNUSED SET OF PLATE BENDING ROLLS, capacity 32ft. by 1in. down to 6ft. by 2½in. mild steel plate; 75 h.p. roll drive, 40 h.p. screw-down; electrics 400/3/50.—BOX No. E6389, "The Engineer." G

FOR SALE

STEAM LOCOMOTIVES FOR SALE

Item	Bore and stroke	Type and make	When built	Working pressure, p.s.i.	Net weight, tons
1.	14×22	040 Barclay	—	160	22
2.	14×22	040 Barclay	—	160	22
3.	14×22	040 Barclay	—	160	22
4.	14×22	040 Barclay	—	160	22
5.	14×22	040 Barclay	1935	160	22
6.	17×24	040 Bagnall	1934	160	36
7.	17×24	040 Bagnall	1940	160	36
8.	17×24	040 Bagnall	1941	160	36
9.	17×24	040 Bagnall	1941	160	36
10.	17×24	040 Bagnall	1944	160	36
11.	18×26	060 Bagnall	1950	180	40½

All the above being recently in service and well-maintained. Insurance reports available.

R. S. HAYES, LIMITED,
BRIDGEND, GLAMORGAN
(TELEPHONE: BRIDGEND 1311/2/3.)
E986 G

VALES PLANT REGISTER, LIMITED,
OFFER FOR IMMEDIATE SALE
500 tons New and Unused Appleby Frodingham Steel Sheet Piling, comprising No. 1B in 24ft. lengths and No. 4 in 65/74ft. lengths.
Further details, 14, Lower Grosvenor Place, London, S.W.1. Telephone: VICtoria 7531, 3501, 8080, 9886 (15 lines). E484 G

TANGYE HYDRAULIC PRESS
200 ton, 12in ram, 12in stroke, 3ft. daylight, bed 16ft. by 2ft. 6in. wide, complete with pump, electric S.R. motor and starter for 400/3/50.
NORMAC, LTD.,
Pepper Road, Leeds, 10.
Tel.: 77779. E993 G

FOR IMMEDIATE DISPOSAL, the following Goliath overhead electrically operated Cranes:—
One 10-ton, 40ft. span Herbert Morris.
Two 40-ton, 40ft. span Babcock and Wilcox.
Two 60-ton, 40ft. span Clyde Crane Co.
All in first-class condition, equal to new.—Full details and price from BOX No. E483, "The Engineer." G

FOR SALE

THE 600 GROUP

RECONDITIONED JONES CRANES with 3 Months' Guarantee

KL.44	Capacity	4	tons
KL.40	,,	3	tons
KL.22	,,	2	tons
KL.15	,,	15	cwts

All Jones Cranes receive 12 months' free after-sales service when supplied by:—

GEORGE COHEN
Sons and Company Limited
WOOD LANE LONDON, W.12
Telephone: SHEPHERDS BUSH 2070
E6338 G

C·E·M

"BENTLEY" Plate Bending Rolls rom 6ft. by ¼in. up to 10ft. by 1in. m.s. capacities. Opening end frame for withdrawing rolled cylinders, self-supporting top roll, finger-tip control, all rolls of generous dia. from solid forged steel, full electrical equipment. Very moderate prices. Early deliveries.

"SEDGWICK" Universal Plate Bending and Folding Machine, 6ft. by ¼in.

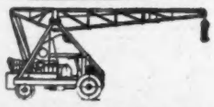
"EDWARDS" Undercrank Guillotine, 8ft. by ¼in.

"PEARSON" Electro Hydrolic Guillotine, 8ft. by ¼in., for early delivery.

Fully detailed stock lists available on request.

CHARLES E. MATTHEWS (Machine Tools) LIMITED,
Gladstone Road, CROYDON.
Tel. No.: Thornton Heath 1783.
Telegrams: "Matolco," Croydon.
E994 G

FOR SALE



MOBILE CRANES
For Sale — For Hire

COLES. Thornycroft 5 ton Diesel Mk. VII, and Austin 3 ton Petrol. Both machines completely reconditioned.
RANSOMES. Standard 6 & 6/10½ ton. Supermobile. 2/3 and 3½/5 ton. Petrol or Diesel. Solid tyred.
MORRIS. Standard. 2½ and 5 ton machines. Diesel or Petrol. Pneumatic tyred.

FORKLIFTS OF ALL TYPES
Lifting up to 7 tons 17' 6" high

Full details from:
NORMAC LTD.
PEPPER ROAD, HUNSLET, LEEDS 10
Telephone: 77779 E998 G

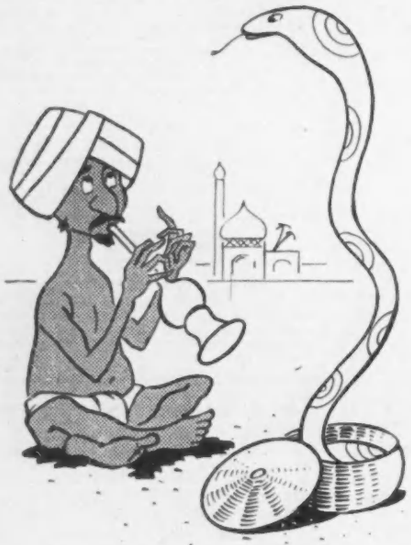
YOU'RE ON THE TARGET IF YOU REMEMBER

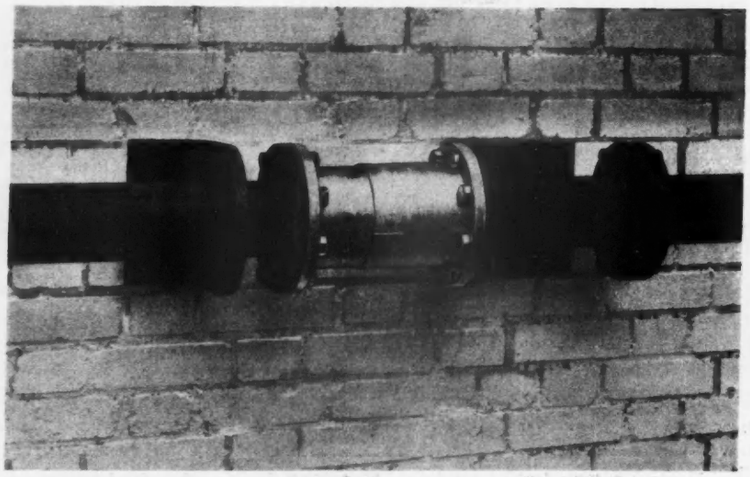
WARDS might have it!

THOS. W. WARD LTD
ALBION WORKS, SHEFFIELD

FLEXIBILITY

In the countless applications involving transmission of fluid under pressure and temperature there is a component to suit every type of installation. A complete range of flexible metallic tubing and bellows in many metals and alloys, with unions, is at your service.





Every up-to-date pipeline designer uses "POWERFLEX" Expansion Joints, incorporating stainless steel bellows of "MULTI-PLY" construction—unequalled for maximum strength and flexion.

Compact—Reliable—Economical—Efficient.

THE POWER FLEXIBLE TUBING COMPANY LTD.,

DERBY WORKS VALE ROAD · LONDON, N.4
Tele: STAMFORD HILL 6696. *Grams: METALFLEX, EASPHONE, LONDON.*

Makers of Reliable Flexible Metallic Components for over half a century

AUCTIONEERS & VALUERS

KNIGHT, FRANK & RUTLEY

SALE & VALUATION OF FACTORIES PLANT AND MACHINERY

20, Hanover Square, W.1.

Telephone: MAYfair 3771

(Factory Department: Ext. 17)

FOR SALE

BOILER EQUIPMENT FOR SALE

DAIRY BOILER EQUIPMENT

One No. 8 Cochran Boiler, 11844 (1930), 1150 lb. per hour.
One No. 8 Cochran Boiler, 13005 (1935), 1150 lb. per hour.
One No. 7 Cochran Boiler, 11233 (1929), 1030 lb. per hour.
Each of the above Boilers are complete with the following :—Pressure gauge, 2 sight glasses, injector, crown and main shut-off steam valves, safety valve, feed valve, blowdown valve.

BURNER EQUIPMENT

Urquhart Vortex Cap type 2-3, atomiser fitted to register with secondary air regulators.
Photo-electric cell unit, with Radiovisor amplifier control box.
D.C. magnetic oil valve, with rectification unit.
Drayton low-level cut-out switch (type 1922).
Teddington thermostatic high-low flame controller for oil.
Oil metering valve.

BOILER-HOUSE EQUIPMENT

Two Andrew Fraser and Co., Ltd., Dari hydraulic oil pumps, 1·3 galls. per minute at 100 p.s.i., complete with pressure-regulating valves, electric controls and vacuum and pressure gauges.
One A. K. Waugh 346V., 3-ph. oil preheater with thermostat and contactor.
One steam-oil preheater with thermostatic control and steam trap.
One Weir water feed pump, size 3½×6×7 (1950), with control valves.
One reducing steam valve, with gauge for steam atomisers.
One air compressor, working pressure 60 p.s.i., with welded air receiver suitable for air atomisation.

INSURANCE COMPANIES' REPORTS AVAILABLE ON ALL EQUIPMENT.

Enquiries should be addressed to Mr. Clarke, Electrical and Engineering Department, Cambridge and District Co-operative Society, Ltd., Sturton Street, Cambridge. E6407 G

600

STEAM TURBO-ALTERNATOR SETS

3000kW., 6600/3/50, MET.-VICK., Pass-out/Condensing Steam Turbo-Alternator Set, date 1948, designed for 340 p.s.i.g. initially, 600 deg. Fah. temperature; also suitable for the following duties :

Output/kW.	Pass-out/lb./hour	Lb. Pressure
3000	60,000	40
1800	40,000	110
1800	40,000 double Pass/out at 1000kW., fully condensing	

2500kW., 440/3/50, B.T.H., speed 3000 r.p.m., 250 p.s.i.g., 630 deg. F., steam consumption approx. 12·8 lb./kW./hr., with surface condenser, circulating pumps, &c. Also suitable for pass-out pressures varying between 18/35 p.s.i.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070; and
STANNINGLEY, NR. LEEDS.
Tel.: Pudsey 2241. E200 G

MOBILE CRANES FOR SALE

One Rapier 8½-ton Super, diesel/electric, fully slewing, jibs to 50ft.
One Rapier 8½-ton Super, petrol/electric, fully slewing.
Two Rapier 6-ton standard petrol/electric, solid tyres; diesel conversion available.
One Morris 5-ton petrol/electric, solid tyres; diesel conversion available.
One Coles/Thornycroft 5 ton, 6×4 diesel Mark 7, wire derricking.
One Tate 5-ton petrol/electric, solid tyres.
One Coles 3-ton fully slewing, petrol/electric on Crossley lorry chassis—cheap.
Two 2½-ton Morris petrol/electric, solid tyres; as new; diesel conversion available.
One 2-ton Rapier full slewing, crawler mounted, diesel engine.
One 2-ton Hydracrane, petrol/hydraulic on 4×4 high-speed chassis.

WILLIAM R. SELWOOD, LIMITED,
CHANDLER'S FORD, HANTS.
'Phone: 2275. E6155 G

AUCTIONEERS & VALUERS

RICHARDS AND PARTNERS

Auctioneers, Surveyors and Valuers

Specialists in the

VALUATION & SALE of INDUSTRIAL PROPERTY PLANT and MACHINERY

3, Arundel Street, London, W.C.2.

TEMple Bar 7471

JOHN FOORD & COMPANY

VALUERS AND ASSESSORS

OF WORKS, FACTORIES ENGINEERING PLANT AND MACHINERY

56, VICTORIA STREET LONDON, S.W.1.

VICTORIA 2002/3/4

Established Over a Century

Thirty-second Sale.

E R

BY ORDER OF THE SECRETARY OF STATE FOR AIR.
No. 25 MAINTENANCE UNIT, ROYAL AIR FORCE, HARTLEBURY, WORCESTERSHIRE.
(4 miles from Kidderminster, 11 miles from Worcester.)

Nock & Joseland

Are instructed to Sell by Auction at the above Unit on :—

THURSDAY, 13TH MARCH, 1958, at 11 a.m. prompt,

A Large Quantity of Valuable MISCELLANEOUS STORES including :—

CLOTHING AND EQUIPMENT,
FOOTWEAR AND REPAIR MATERIALS,
PARACHUTES AND DINGHY EQUIPMENT,
PHOTOGRAPHIC EQUIPMENT,
RADIO AND ELECTRICAL EQUIPMENT,
METAL FUEL TANKS,
AIRCRAFT SPARES,
GENERAL STORES.

VIEWING

The Lots are on view at Hartlebury on Wednesday, 12th March, 1958, between the hours of 9 a.m. and 4 p.m., and on the morning of the Sale Day between the hours of 8 a.m. and 11 a.m.
Admission by Catalogue only, Price Sixpence each (Postal Orders NOT Stamps), which can be obtained from the Auctioneers :—
Nock & Joseland, Bank Buildings, Kidderminster.
Tel.: 2053 and 4211. E6247 J

FOR SALE

FOR SALE

6-ton Ransomes and Rapier Standard Pet./Elec. Mobile Crane on solid rubber tyres.
6-ton Ransomes and Rapier Super Pet./Elec. Mobile Crane on solid rubber tyres.
5-ton Morris Versatile Diesel/Elec. Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane, 4ft. 8½in. gauge, 35ft. jib.

WILLIAM G. SEARCH, LIMITED,
WHITEHALL ROAD, LEEDS, 12.
Tel.: 639081 (10 lines).
SEARCH (LIVERPOOL), LIMITED,
KIRKBY TRADING ESTATE, LIVERPOOL.
Simonswood 2634–5–6. E6134 G

AUCTIONEERS & VALUERS

Established 1850

WHEATLEY KIRK PRICE & CO.

E. L. JUDSON, F.R.I.C.S., F.A.I.
E. BEDDARD, A.I.MECH.E., F.A.I., F.P.A.
M. S. CHEAVIN, F.A.I.
G. E. GIBBS, F.A.I., F.P.A.

SURVEYORS, VALUERS and AUCTIONEERS of FACTORIES, PLANT and MACHINERY

FIRE LOSS ASSESSORS

9, REX PLACE, LONDON, W.1.

Telephone: HYDE PARK 8844/5/6 (3 lines)

Established 1807

FULLER, HORSEY

SONS AND CASSELL

Specialists

IN THE

SALE & VALUATION

OF

WORKS and MANUFACTORIES ENGINEERING PLANT and MACHINERY

10, LLOYD'S AVENUE, LONDON E.C.3.

Telephone: ROYAL 4861

AUCTIONEERS & VALUERS

ESTABLISHED 1877

LEOPOLD FARMER & SONS

conduct

AUCTION SALES

OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES

and

VALUATIONS

for Public Issue, Stock Exchange Quotation, Balance Sheet, Probate Insurance and other purposes.

FACTORY INVESTMENTS AND MORTGAGES ARRANGED

46, GRESHAM STREET, LONDON, E.C.2.

Telephone: Monarch 3422 (8 lines)
Telegrams: Sites, London

HENRY BUTCHER AND CO.

Auctioneers, Valuers and Surveyors

Specialising in the

SALE & VALUATION

of

ENGINEERING & ALLIED WORKS PLANT & MACHINERY

73, Chancery Lane, London, W.C.2.

HOLBORN 8411 (8 lines)

E. R.

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

AUCTION PROGRAMME

		Main Location	*Auctioneers*
March 12	Miscellaneous stores, including tools and tool kits, bicycles, welding plant, camp equipment, etc.	Central Ordnance Sub-Depot, Westbury, Wilts. (Sale at Corn Exchange, Devizes.)	FARRANT, WIGHTMAN & PINNIGER (Dept. L), 38, High Street, Swindon, Wilts. (Tel.: 5151/5152.)
March 18–19	Miscellaneous stores, including tentage, hand-tools, packing materials, workshop equipment, etc.	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
March 18–21 & 24–28	Vehicles, earth moving equipment, cranes, trailers, tractors, motor cycles, etc.	M.O.S. Storage Depot, Roddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)
March 26	Miscellaneous stores, including :—	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorkshire	BARTLE & SON (Dept. L), 50–52 Merrion Street, Leeds, 2. (Tel.: 2–0698.)
	Blankets, canvas, tentage, rags, webbing, hessian, haversacks, kitbags, clothing, including greatcoats, shirts, wool vests, skirts, slacks, berets, overalls, leather jerkins, women's boots and shoes, canvas shoes, pullovers, rubber boots, oversuits, anti-gas capes, old batteries, generating sets, concrete mixers, 2 stone crushers, 4 Decauville locos, gravity and portable runway bicycles, weighing machines, builders' and plumbers' stores and tools, furniture, including chairs, tables, etc., cutlery, etc.		
April 1–2	Machine tools and miscellaneous stores, including textiles, clothing, etc.	M.O.S. Sub-Depot, Lily Lane, Byley, Middlewich, Cheshire. (Sale at New Islington Public Halls, Ancoats, Manchester.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)

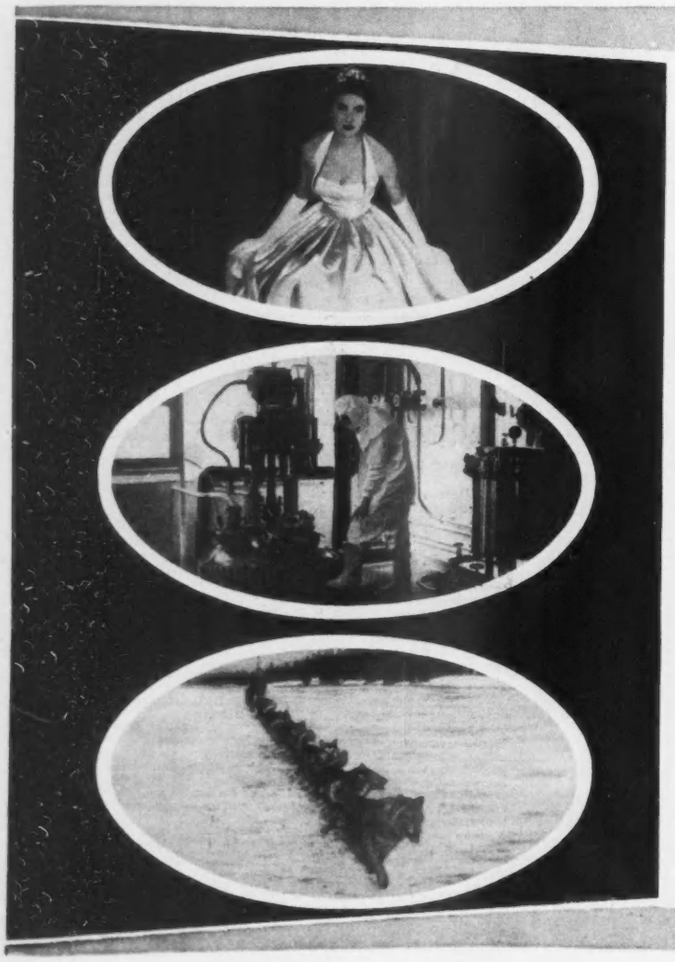
CATALOGUES (6d. each—P.O.s) available *only* from the Auctioneers shown above.

E975 J

and talking of Galvanizing
here's another
BIG JOB
ready on TIME
Our technical staff will be pleased to deal with any Galvanizing problem you care to submit.
Kings Norton 4211/2

MIDLAND GALVANIZERS LIMITED

Kings Norton Factory Centre · Birmingham 30



You never know who you'll meet . . .

. . . or what new subjects will be covered in the pages of THE MOND MAGAZINE. Its articles and features, illustrated in colour, deal with a variety of topics related to the many products of the Mond Nickel Company and its associates. Issue Number Four is now available. Are you on the regular mailing list?

CONTENTS OF THIS ISSUE INCLUDE:

Platinum Cathodes Extend Valve Life
Nickel Alloys in Fork Lift Trucks
How Cobalt reveals Art Forgeries
Prospecting Minerals
How Chromium-Nickel Alloys help the Brewer

THE MOND MAGAZINE will be sent regularly on publication to all who are interested.

Send us your name and address

THE MOND NICKEL COMPANY LIMITED · THAMES HOUSE · MILLBANK · LONDON S.W.1

TAG MM

INDEX TO ADVERTISERS

	PAGE
Abingdon King Dick, Ltd.	85
Airnesco Products, Ltd.	44
Alldays & Onions, Ltd.	43
Allen, E., & Co., Ltd.	109
Anderson-Grice Co., Ltd.	22
Anderton Springs, Ltd.	87
Angus, G., & Co., Ltd.	104
Armstrong Patents Co., Ltd.	82
Armstrong Stevens & Son, Ltd.	52
Atlas Preservative Co., Ltd.	89
Aurora Gearing Co., Ltd.	33
Automotive Products Co., Ltd.	18
Barimar, Ltd.	7
Barlow & Chidlaw, Ltd.	55
Barlow-Whitney, Ltd.	10
Barron, W. S., & Son, Ltd.	52
Beardmore, W., & Co., Ltd.	90
Bell's Asbestos & Engineering, Ltd.	Cover i
Bennett & Sayer, Ltd.	70
Bird, W. H. & Sons, Ltd.	23
Birfield Industries, Ltd.	12–75
Birmingham & Blackburn Construction Co., Ltd.	33
Booth, J., & Bros.	35
Booth, J., & Co., Ltd.	20
Braby, F., & Co., Ltd.	56
Brett's Patent Lifter Co., Ltd.	24
Brightside Plating Co., Ltd.	48
British Aluminium Co., Ltd.	94
British Electrical Repairs, Ltd.	47
British Ermeto Corp., Ltd.	106
British Paints, Ltd.	34
British Ropes, Ltd.	6
British Thomson-Houston Co., Ltd.	3
Broadbent & Co. (Rochdale), Ltd.	82
Broadbent, R., & Son, Ltd.	30
Broom & Wade, Ltd.	41
Brown, D., Corporation (Sales), Ltd.	83
Brown, E. G., & Co., Ltd.	47
Brownlie & Murray, Ltd.	24
Budworth, D., Ltd.	66
Butcher, H., & Co.	129
Butters Bros. & Co., Ltd.	25
Caird, F., Ltd.	69
Callow, F. E. (Engineers), Ltd.	54
Chesterfield Tube Co., Ltd.	29
Clarke, Chapman & Co., Ltd.	91
Clyde Crane & Booth, Ltd.	35
Clyde Crane & Engineering Co.	35
Cochran & Co., Annan, Ltd.	55
Cohen, G., Sons & Co., Ltd.	7–73
Cooper & Co. (B'ham), Ltd.	Cover ii
Cory Brothers & Co., Ltd.	19
Crabtree, J. A., & Co., Ltd.	4
Crockatt, W., & Sons, Ltd.	54
Crofts (Engineers), Ltd.	38–39
Crompton Parkinson, Ltd.	74
Cross Manufacturing Co. (1938), Ltd.	84
Crowthorn Engineering Co., Ltd.	87
DEW	29
Darwins Bright Steels, Ltd.	16
Dawson & Downie, Ltd.	71
Dilloway, P. W., Ltd.	115
Drum Engineering Co., Ltd.	100
Drummond - Asquith (Sales), Ltd.	53
Eclipse Foundry & Engineering Co. (Dudley), Ltd.	47
Electronic Engineering	87
Fairitt Engineering Co., Ltd.	100
Farmer, L., & Sons	129
Finucane, W., Ltd.	24
Firth, T., & Brown, J., Ltd.	67
Firth Brown Tools, Ltd.	76
Flexo Plywood Industries, Ltd.	Cover iv
Foord, J., & Co.	129
Fuller, Horsey, Sons & Cassell	129
Gandy, Ltd.	118
General Electric Co., Ltd.	30
Gibson, A. L., & Co., Ltd.	82
Glenfield & Kennedy, Ltd.	13
Goodwin, R., & Sons (Engineers), Ltd.	51
Goodyear Pumps, Ltd.	102
Grafton Cranes, Ltd.	72
Greenwich Insulation Co., Ltd.	42
Greenwood's Standard Gear Cutting Co., Ltd.	62
Hadfields, Ltd.	114
Harbutt's Plasticine, Ltd.	48
Harland & Wolff, Ltd.	103
Harlow, R., & Son, Ltd.	118
Harvey, G. A., & Co (London), Ltd.	49
Head Wrightson Processes, Ltd.	86
Holman Michell & Co., Ltd.	51
Imperial Chemical Industries, Ltd.	40
Ince Forge Co.	70
International Mechanite Metal Co., Ltd.	80
Jackman, J. W., & Co., Ltd.	22
Johnson & Phillips, Ltd.	79
Kay, S., Rubber Co., Ltd.	71
Kempe's Engineers Year-Book	123
Kitchen & Wade, Ltd.	107
Knight, Frank & Rutley	129
Lafarge Aluminous Cement Co., Ltd.	61
Langley Alloys, Ltd.	108
Ledward & Beckett, Ltd.	69
Lee, A., & Sons, Ltd.	60
Leeds Engineering & Hydraulic Co., Ltd.	81
Lobnitz & Co., Ltd.	84
Loveridge, Ltd.	84
Machinery Installations, Ltd.	28
MacLellan, P. & W., Ltd.	65
McNeil, C., Ltd.	30
Mallinson & Eckersley, Ltd.	131
Manganese Bronze & Brass Co., Ltd.	57
Massey, B. & S., Ltd.	78
Mather & Platt, Ltd.	111
Matthews & Yates, Ltd.	105
Mavitta Drafting Machines, Ltd.	98
Mavor & Coulson, Ltd.	36
Maxim Conveyors (England), Ltd.	131
Megator Pumps & Compressors, Ltd.	116
Meritus (Barnet), Ltd.	62
Metal Constructions Ltd.	Cover ii
Metropolitan - Vickers Electrical Co., Ltd.	64–93
Meyer, W. A., Ltd.	118
Michell Bearings, Ltd.	30
Midgley & Sutcliffe, Ltd.	2
Midland Galvanizers, Ltd.	130
Miller, A. B., & Co.	23
Mills, G. (Engineers), Ltd.	84
Mirrlees (Engineers), Ltd.	108
Modern Conveyors, Ltd.	69
Mole, S., & Sons (Green Lane Foundry), Ltd.	22
Mond Nickel Co., Ltd.	130
Monochrome, Ltd.	62
Mono Pumps, Ltd.	82
Morgan Crucible Co., Ltd.	Cover iii
Neill, J., & Co. (Sheffield), Ltd.	70
New Welbeck, Ltd.	111
Newall, A. P., & Co., Ltd.	78
Newton Chambers & Co., Ltd.	27
Newton Sales Co., Ltd.	66
Niagara Screens (Great Britain), Ltd.	85
Nicol & Andrew, Ltd.	88
Non-Ferrous Die Casting Co., Ltd.	70
North British Rubber Co., Ltd.	26
Norton, Sir J. Farmer & Co., Ltd.	5
Opperman Gears, Ltd.	50
Optical-Mechanical (Instruments), Ltd.	88
Oscard, J., & Co.	66
Palmer, G. A. Stanley, Ltd.	19
Parsons, C. A., & Co., Ltd.	11
Peckett & Sons, Ltd.	96
Pegler & Louden, Ltd.	88
Perry Chain Co., Ltd.	37
Pinchin, Johnson & Co.	51
Plannair, Ltd.	98
Platt Malleable Castings, Ltd.	81
Plenty & Son, Ltd.	54
Plowright Bros., Ltd.	8
Plus Gas Co., Ltd.	71
Pollard Bearings, Ltd.	113
Pollard, F., & Co., Ltd.	33
Positive Lock Washer Co., Ltd.	72
Power Flexible Tubing Co., Ltd.	128
Price, J. T., & Co., Ltd.	103
Priest Furnaces, Ltd.	24
Prior Stokers, Ltd.	98
Quasi-Arc, Ltd.	14
Radiovisor Parent, Ltd.	95
Ransome & Marles Bearing Co., Ltd.	17
Rawlplug Co., Ltd.	19
Reavell & Co., Ltd.	99
Record Electrical Co., Ltd.	85
Renold Chains, Ltd.	97
Renshaw Foundry, Ltd.	30
Revolvo, Ltd.	65
Reyrolle, A., & Co., Ltd.	63
Rhodes, B., & Son, Ltd.	51
Rhodes, J., & Sons, Ltd.	106
Richards & Partners	129
Richards, C., & Sons, Ltd.	48
Richards, J., & Sons, Ltd.	44
Richmond Welding Co.	24
Robertson & Ferguson, Ltd.	5
Robinson, L., & Co. (Gillingham), Ltd.	100
Robson, G., & Co. (Conveyors), Ltd.	48
Rose, Downs & Thompson, Ltd.	96
Russell, G., & Co., Ltd.	131
Rye, Claude, Bearings	70
Sadi Engineering Co., Ltd.	99
St. Georges Engineers, Ltd.	95
Saunders Valve Co., Ltd.	9
Schieldrop & Co., Ltd.	72
Schiess, A. G.	101
Shaw & McInnes, Ltd.	21
Shotton Bros. Ltd.	69
Skefko Ball Bearing Co., Ltd.	68
Smedley Bros., Ltd.	24
Smith, J. (Keighley), Ltd.	45
Smith, S., & Sons (England), Ltd.	77
South Durham Steel and Iron Co., Ltd.	58
Spencer & Sons (Market Harborough), Ltd.	52
Sperry Gyroscope Co., Ltd.	132
Staedtler, J. S., Ltd.	40
Standard Piston Ring & Engineering Co., Ltd.	34
Steel, J. M., & Co., Ltd.	107
Steele & Cowlishaw, Ltd.	65
Stone, J. B., & Co., Ltd.	119
Sunbeam Anti-Corrosives, Ltd.	43
Tangves, Ltd.	31
Taylor & Hubbard, Ltd.	81
Taylor Stoker Co., Ltd.	21
Technological Institute of Gt. Britain	122
Thorn, J., & Sons, Ltd.	55
Town, F., & Sons, Ltd.	21
Unbrako Socket Screw Co., Ltd.	107
Unit Superheater & Pipe Co., Ltd.	8
Vanguard Valve Co., Ltd.	23
Visco Engineering Co., Ltd.	2
Vokes, Ltd.	112
Ward, T. W., Ltd.	128
Weir, G. & J., Ltd.	117
Welding Technical Services, Ltd.	88
Wellman Bibby Co., Ltd.	70
Wellman Smith Owen Engineering Corporation, Ltd.	32
Wells, A. C., & Co., Ltd.	33
Weston, C., & Co., Ltd.	92
Westool, Ltd.	72
Wharton Crane & Hoist Co., Ltd.	110
Wheatley Kirk, Price & Co.	129
Wiggin, H., & Co., Ltd.	24
Wiggins, P., & Sons	131
Wood, E., & Co., Ltd.	46
Woodfield Hoist & Associated Industries, Ltd.	15
Wootton, Bros., Ltd.	62
Worthington-Simpson, Ltd.	59
Wynstruments, Ltd.	34
Yarrow & Co., Ltd.	28
Zerny Engineering Co., Ltd.	44

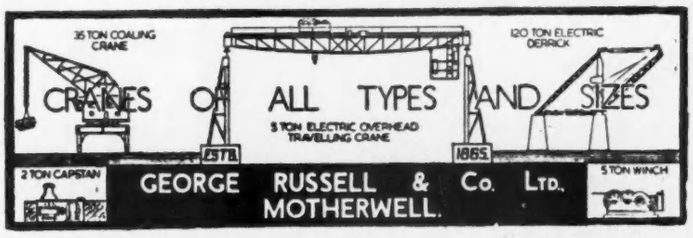
MICA FOR INSULATION WATER GAUGES, ETC.

F. WIGGINS & SONS

Phone: SYDenham 7660

9-11 TREDOWN ROAD, SYDENHAM, S.E.26

Established 1840


35 TON COALING CRANE
120 TON ELECTRIC DERRICK
CRANES OF ALL TYPES AND SIZES
5 TON ELECTRIC OVERHEAD TRAVELLING CRANE
2 TON CAPSTAN
GEORGE RUSSELL & Co. LTD.
MOTHERWELL.
5 TON WINCH

PITCH PINE

The engineer's Timber

affording highest strength with natural durability

Large sections a speciality

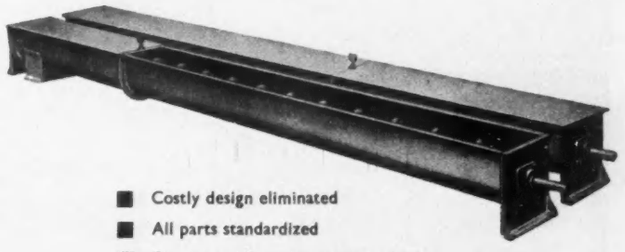
MALLINSON & ECKERSLEY LTD.,

PITCH PINE SPECIALISTS

23, BLANTYRE STREET, CHESTER ROAD, MANCHESTER 15

TELEPHONE: DEANSGATE 5867-9 TELEGRAMS: 'PITCH PINE' MANCHESTER

MAXIMum production —minimum outlay



- Costly design eliminated
- All parts standardized
- Operate with minimum supervision
- Ideal for bulk handling in Flour Mills, Sugar Refineries, Fertilizer Plants, Cement Works, Chemical Plants, etc

MAXIM

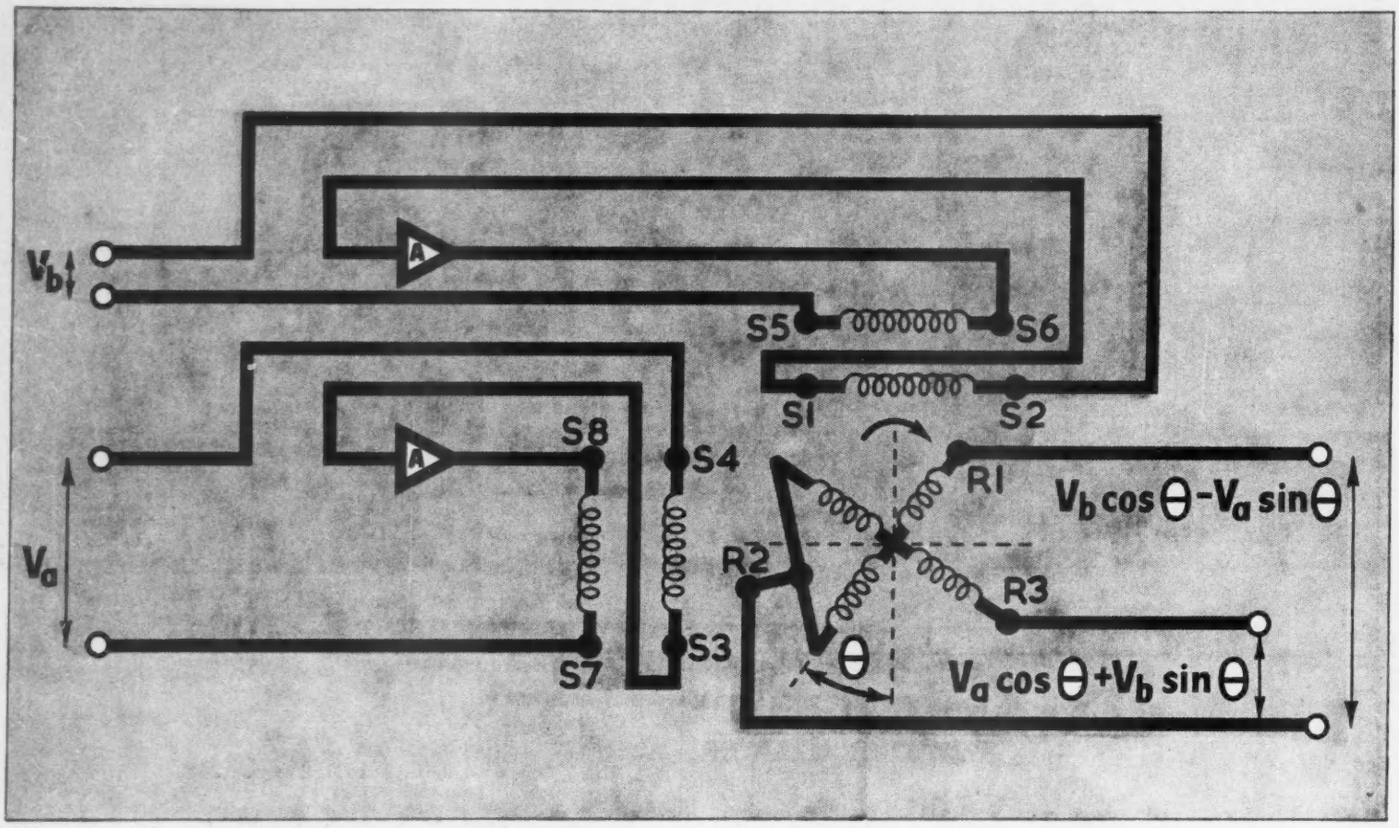
All types of Belt Conveyors and General Material Handling Equipment

CONVEYORS (ENGLAND) LTD.

Crabtree Manorway, Belvedere, Kent

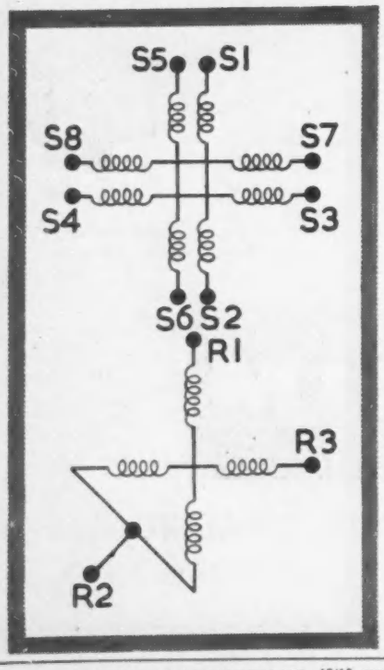
ERITH 4223 & 5751

Another Synchro Unit added to the SPERRY range



Synchro Feedback Resolver

15RSF4SL



This Resolver is used in Analogue Computers to multiply the analogue signal by the sine or cosine of the angle set in on the rotor shaft.

A feedback amplifier is employed in both stator windings to reduce the variation of transformation ratio with signal level. By this means the accuracy is improved by a factor of at least 2, compared with the accuracy when no feedback amplifiers are employed, and phase shift is reduced to negligible proportions.

The Sperry Synchro Feedback Resolver is British-designed and manufactured with British materials throughout, and it is available *now*. Send for technical data sheet.

SPERRY GYROSCOPE COMPANY LIMITED

Great West Road · Brentford · Middlesex Telephone: EALing 6771

PRINTED BY GEORGE REVEIRS, LTD., 10/12, ROSEBERY AVENUE, LONDON, E.C.1, FOR THE PROPRIETORS, MORGAN BROTHERS (PUBLISHERS), LTD., 28, ESSEX STREET, STRAND, LONDON, W.C.2. 7/1/0½

MORGANITE CARBON

There's nothing quite like it . . .

. . . that's the beauty of it

Look at these advantages — Light as aluminium. High resistance to wear. Wide range of resistance to chemical attack. Easily machined. High thermal conductivity. Excellent heat radiation. Not wetted by molten metal or slags. Non-seizing. Self-lubricating. High resistance to thermal shock. Good mechanical strength at high temperatures. Good electrical conductivity. Available in impervious forms. Low thermal expansion. These properties give Morganite Carbon vast potentialities for the design engineer. Talk them over with our technical staff.

The illustration shows a Rectifier Control Grid, a Rectifier Anode, a Boat, a Bearing, a Piston Ring, a Tube and a Valve Anode—just a small selection of products showing the remarkable versatility of Morganite Carbon.

MORGANS

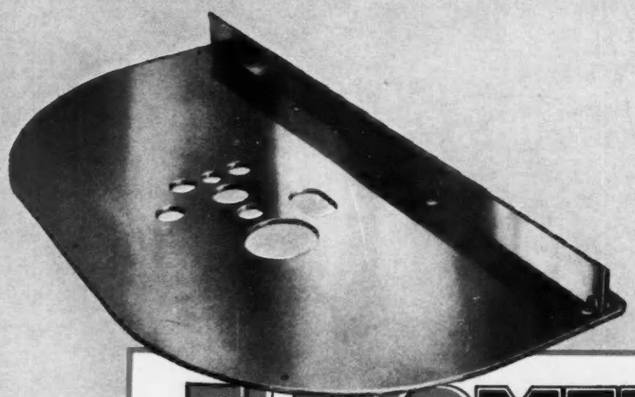
CARBON AND GRAPHITE—ELECTRICAL, CHEMICAL AND MECHANICAL; CRUCIBLES, FURNACES, REFRACTORIES; RADIO PARTS, SINTERED METAL PRODUCTS AND ELECTRIC FURNACE ELEMENTS.

THE MORGAN CRUCIBLE COMPANY LTD., BATTERSEA CHURCH ROAD, LONDON, S.W.11. BAT: 8822

C58 A

The Engineer

MARCH 7, 1958



Flexometal shaped panel for laundry machine, faced with aluminium and sealed at the edges.

By Courtesy of Brown & Green of Luton.

FLEXOMETAL

ANY TYPE OF METAL, bonded on one or both sides of Plywood, Asbestos Board, Hardboard, Chipboard, Insulation Material (Cork Board, Onazote, etc.) Dufaylite honeycomb or any other rigid material.

It combines the following advantages

STRENGTH : STIFFNESS : NON-DRUMMING

VERMIN PROOF : WEATHER RESISTANT

FIRE RESISTANT : HYGIENIC : WEIGHT-SAVING

Available in sheet form or can be supplied in any desired shape, size, and/or construction, with edges sealed if required.

Typical uses in addition to those illustrated include shower and lavatory cubicles for factories and schools, swimming bath cubicles, hospital trolley shelves, heavy-duty doors of all types, coach body panels, ducting, insulation panels, wall and ceiling linings, bench and counter tops, stanchion casings, infill panels, insulated covers for industrial dryers, fascia panels, mash tun covers, feed boards, machine hoods and tables, bulkheads, weatherproof notice boards, lift car linings, louvre panels, partitions, etc.

YOUR ENQUIRIES ARE INVITED:

FLEXO PLYWOOD INDUSTRIES LTD., South Chingford, London, E.4.

Telephone: Silverthorn 2666 (7 lines) *Associated with Cork Manufacturing Co. Ltd.*

FLEXOMETAL

One of a pair of sugar containers, measuring 36 ft. in length, constructed by Henry Simon Ltd., Cheadle Heath, Stockport, and shown ready for despatch. All panelling throughout is insulated FLEXOMETAL.